

Title: Development of New Strawberry Varieties Adapted to the NC Plasticulture System

Report

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Objective: To evaluate advanced selections of strawberries from the NC State University strawberry breeding program at research stations and on-farm locations in the Southeastern United States.

Justification and Description:

For the past 20 years, three cultivars have been the backbone of the Mid-South and southeastern US strawberry production acreage. Strawberries that are adapted to the states (excluding FL) in the “southern region” have distinct characteristics. They are typically short day plants and require low to moderate chilling hours. ‘Chandler’ released by the University of California (UC) in 1982, is most widely adapted to the range of climates and soils across the southern regions. ‘Chandler’, is a short-day cultivar with consistently high yields, excellent flavor and is a favorite of pick-your-own customers. ‘Camarosa’ was released by UC in 1992. A third cultivar, ‘Sweet Charlie’, a variety from the University of Florida is the cultivar that is most often planted when growers want to establish fruit in early market windows, as it ripens 5-7 days before ‘Chandler’. However, the yield of ‘Sweet Charlie’ is low in comparison to the others.

In recent years, the strawberry breeding program at NC State University has developed a number of advanced lines of strawberry that are uniquely adapted to the climate of the Southeastern US. Data collected since 2015, has indicated that 2 “elite selections” continue to do well. NCS 10-156 is an early genotype that has uniform fruit with excellent flavor, rich red color that has consistently good yields. It is a potential ‘Sweet Charlie’ replacement. It is a bit soft, comparable or better than ‘Sweet Charlie’ or ‘Chandler’. The other promising selection is NCS 10-038. It is a potential ‘Chandler’ replacement with high yields, firmer fruit and its more uniform production across the season than ‘Chandler’.

Methodologies

Experimental Design and On-farm testing

Replicated trials were conducted at the Central Crops Research Station (CCRS) in Clayton NC in 2016-17. Plants were set on October 4, 2016. We tested 20 genotypes (numbered selections and named cultivars), including advanced selections from our breeding program and several cultivars from the UC Davis, UFlorida and Lassen Canyon programs.

We harvested fruit from 20 plant plots replicated 3 times. Data was analyzed (ANOVA and Tukey's HSD) using JMP software (JMP PRO 12.2). Total yield (all the berries), marketable yield (berries greater than 10 g and free of noticeable defects), and berry size (based on 25 random marketable berries) was collected over an approximate 6-week period. Data is also presented as a % of marketable yield, and % of Chandler yield (Table1). Data was analyzed using ANOVA, and Tukey MSD (JMP Pro 12.2). The HSD at the bottom of the columns indicates the number that statistically distinguishes yield of one cultivar from the other.

Figures 1 and 2 are close-up shots of NCS 10-038 and NCS 10-156, the two promising NCSU selections.

We also sent at least 100 plants of NCS 10-156 and NCS 10-038 to growers in North Carolina, Virginia and South Carolina. A summary of their comments is in Table 2.

Institutional collaborations included NC A&T University in Greensboro, NC (Sanjun Gu), the USDA Genetic Improvement of Fruits and Vegetable Lab in Beltsville MD (Kim Lewers), and the USDA-ARS in Corvallis OR (Chad Finn). Data from USDA trials is not available, as the plants were not in production in 2017.

At NC A&T, the trials were conducted in tunnels that were managed organically. They were planted on 9/28/2016. The high tunnel was 30' x 96'. Plugs were planted on the side beds in the tunnel (8 beds total), two rows per bed. In-row spacing 12 in inches. Beds were covered with black plastic mulch. Two 12"-drip lines per bed. 1.5 oz/yd² row covers were used for frost protection.

Results

Overall, in 2017, the trial at CCRS suffered significant plant loss due to disease and therefore impacted our yield data. However, relative yield of NCS 10-038 and NCS 10-156 was similar to what we had in the past.

NCS 10-038 had the highest total and marketable yield of all the genotypes planted in this year's trial. The percent marketable yield more than twice (219%) that of Chandler. For the past 3 years NCS 10-038 has had the highest yield in all of the trials at the research stations (see previous reports). NCS 10-038 harvest begins slow, peaks mid-season and remains steady in the latter half of the season (Figure 3). Peak fruiting season of NCS 10-038 is comparable to Camarosa, with peak yield occurring in week 4.

The yield of NCS 10-156 is moderate in comparison to the other cultivars in the trial. However, the marketable yield of NCS 10-156 was almost 160% compared to the Chandler. NCS10-156 is considered an early season producer, with early season yields comparable to Sweet Charlie (Figure 4).

A summary of grower feedback is presented in Table 2. In general, the growers preferred NCS 10-038 over NCS 10-156. All of the grower cooperators were primarily wholesale marketers, so they did not like the soft texture of NCS 10-156.

In 2017, seeds of NCS 10-156 were more noticeable than in the past. Seeds were either at or above the surface of the fruit. This trait made the fruit less desirable. We will be trialing several sources of the plants again in 2017-18 to determine if there is an off-type occurring due to the tissue culture process.

Data from NC A&T tunnel and field trials are presented in Tables 3-6. In the high tunnel yields were in general higher than the same genotypes planted in the field. In the tunnel, NCS 10-038 and Fronteras produced the highest marketable yields. NCS 10-156 produced fruit earlier in the field than in the tunnel. Neither NCS 10-156 or NCS 10-038 produced fruit in the winter months in the tunnel.

Conclusions

Based on research station and grower feedback, NCS 10-156 was the sweetest, but not firm, best for local markets. We will be testing at smaller farms in 2018. NCS 10-038, had very high yields, with quality similar to Camarosa. Shipping potential appears to be similar to Camarosa.

Both NCS 10-038 and NCS 10-156 had higher yield under tunnels than in the field when grown organically. Neither selection produced fruit in the off-season in the tunnel.

Impact Statement

Although we had hoped to release these selections in 2017, we are waiting for another year of feedback from growers. Larger growers want one more look at NCS 10-038 to see if it fits into their schedule. In addition, we want to determine if NCS 10-156 would be a good early season alternative to Sweet Charlie for smaller growers. Finally, we found that tunnel production may improve yield of both selections, but will not change season of ripening.

References

NA

Table 1. Yield data of 20 genotypes tested at the Central Crops Research Station in Clayton NC 2017. NCSU selections in red.

| Genotype | Total Yield (g/plant) | Total Yield (lbs./A) | Marketable Yield (g/plant) | Marketable Yield (lbs./A) | Percentage Cull (% of total) | Marketable Percent of Chandler | Average berry weight (g) |
|----------------------|-----------------------|----------------------|----------------------------|---------------------------|------------------------------|--------------------------------|--------------------------|
| NCS 10-038 | 976 | 36563 | 617 | 23122 | 34.693 | 219.0% | 23.9 |
| Camino Real | 828 | 31027 | 504 | 18871 | 39.177 | 178.8% | 24.1 |
| Sweet Ann | 795 | 29812 | 378 | 14170 | 51.45 | 134.2% | 32.8 |
| Fronteras | 766 | 28701 | 493 | 18460 | 36.689 | 174.9% | 29.6 |
| Winter Dawn | 729 | 27328 | 584 | 21869 | 19.815 | 207.2% | 20.7 |
| Camarosa | 718 | 26892 | 499 | 18710 | 28.791 | 177.2% | 23.1 |
| Winter Star | 716 | 26823 | 597 | 22381 | 16.727 | 212.0% | 24.1 |
| Scarlet | 692 | 25949 | 346 | 12980 | 49.994 | 123.0% | 34.9 |
| Ruby June | 671 | 25153 | 433 | 16230 | 35.172 | 153.7% | 23.9 |
| Sensation | 642 | 24066 | 520 | 19499 | 19.526 | 184.7% | 30.7 |
| Festival | 637 | 23864 | 486 | 18228 | 22.198 | 172.7% | 21.9 |
| Radiance | 623 | 23351 | 555 | 20813 | 10.977 | 197.1% | 26.7 |
| NCS 10-156 | 556 | 20850 | 449 | 16828 | 19.542 | 159.4% | 19.7 |
| Chandler | 483 | 18092 | 282 | 10557 | 41.679 | 100.0% | 20.6 |
| Sweet Charlie | 474 | 17756 | 394 | 14764 | 16.897 | 139.9% | 19.9 |
| San Andreas | 469 | 17579 | 351 | 13171 | 24.967 | 124.8% | 26.7 |
| Pentaluma | 442 | 16549 | 321 | 12035 | 28.274 | 114.0% | 29.7 |
| Lucia | 419 | 15722 | 204 | 7632 | 51.952 | 72.3% | 25.1 |
| Albion | 185 | 6938 | 141 | 5299 | 23.179 | 50.2% | 23.7 |
| NCK 12-184 | 153 | 5745 | 77 | 2870 | 48.738 | 27.2% | 12.9 |
| TUKEY HSD | | 17838 | | 12500 | 20.188 | | 6.6 |

Table 2. Grower comments from On-farm evaluation of NCS 10-038 and NCS 10-156

| NCS 10-038 | NCS 10-156 |
|--|---|
| <ul style="list-style-type: none"> • Nice fruit size and set | <ul style="list-style-type: none"> • Fruit small |
| <ul style="list-style-type: none"> • Orange color | <ul style="list-style-type: none"> • Early |
| <ul style="list-style-type: none"> • Flavor not as good as Camarosa | <ul style="list-style-type: none"> • Seedy |
| <ul style="list-style-type: none"> • Yield impressive | <ul style="list-style-type: none"> • Soft |
| <ul style="list-style-type: none"> • Post harvest unknown | <ul style="list-style-type: none"> • Flavor a plus, plus |
| <ul style="list-style-type: none"> • Would try again | <ul style="list-style-type: none"> • Would try again |
| <ul style="list-style-type: none"> • Nice open canopy | <ul style="list-style-type: none"> • Might be best for PYO |



Figure 1. NCS 10-038, an elite selection from the NCSU strawberry breeding program, with very high yields, moderately firm fruit, with peak production in mid-season.



Figure 2. NCS 10-156, and elite selection from the NCSU strawberry breeding program, with moderate to high yields, excellent flavor and starts producing fruit early in the season.

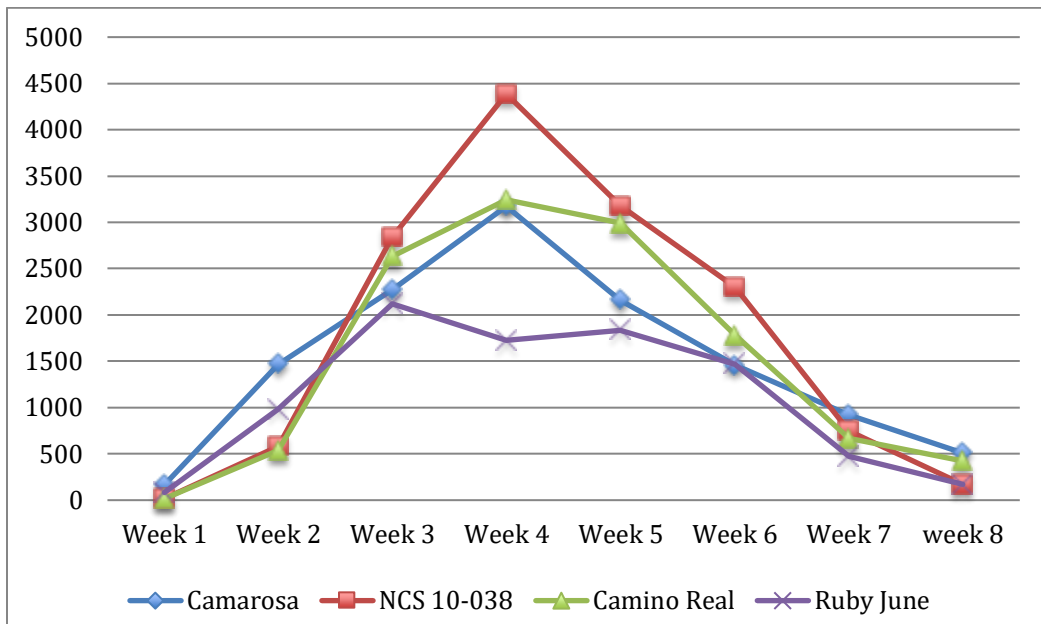


Figure 3. Weekly marketable yield (g/plot) of 4 genotypes grown at the Central Crops Research Station, Clayton NC in 2016.

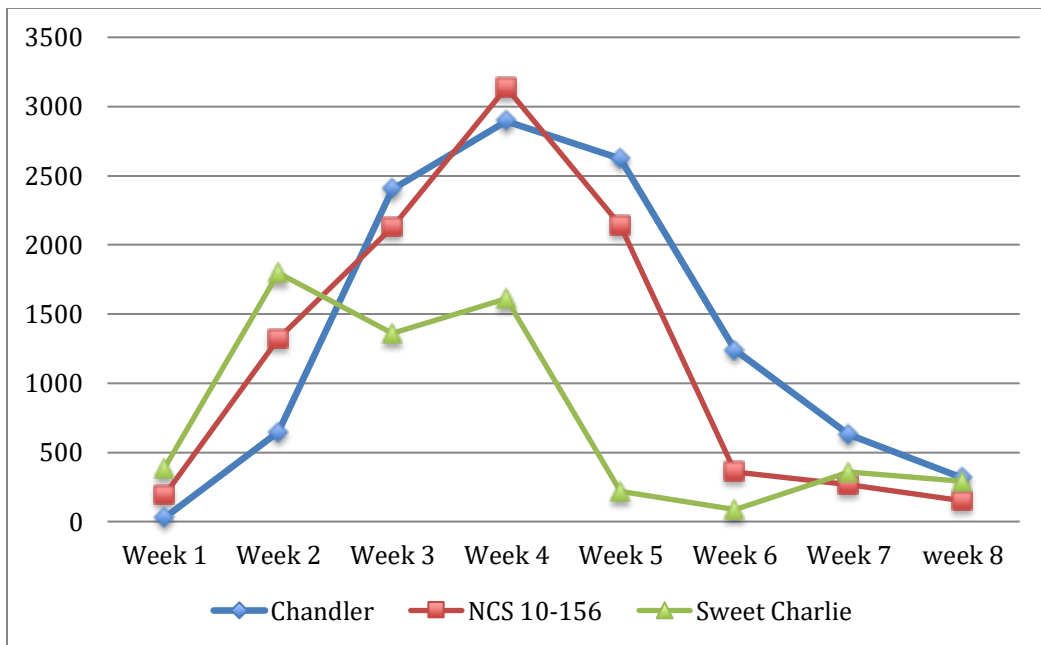


Figure 4. Weekly marketable yield (g/plot) of 3 genotypes of strawberry at the Central Crops Research Station in Clayton, NC in 2016. Note that NCS 10-156 begins to produce fruit earlier than Chandler.

Table 5. High Tunnel Monthly Yield Breakdown, NC A&T Greensboro, NC.

| | Nov-Dec | | | | Jan-Feb | | | | March | | | | April | | | | May | | | |
|-------------|------------------|---|-------------|---|------------------|----|-------------|----|------------------|----|-------------|----|------------------|----|-------------|----|------------------|---|-------------|---|
| | Marketable Yield | | Total Yield | | Marketable Yield | | Total Yield | | Marketable Yield | | Total Yield | | Marketable Yield | | Total Yield | | Marketable Yield | | Total Yield | |
| Flavorfest | 0.0 | b | 0.0 | b | 0.0 | b | 0.0 | c | 0.0 | c | 0.3 | c | 10.0 | c | 31.9 | c | 165.9 | a | 373.5 | a |
| Florida 127 | 0.0 | b | 1.3 | b | 0.6 | b | 1.4 | bc | 8.8 | a | 16.9 | a | 70.6 | b | 199.2 | ab | 142.8 | a | 259.3 | a |
| Frontera | 0.5 | b | 2.1 | b | 2.0 | a | 3.2 | bc | 0.0 | c | 0.1 | c | 57.1 | bc | 152.3 | b | 143.9 | a | 257.2 | a |
| NCS10038 | 0.0 | b | 0.0 | b | 0.0 | b | 0.0 | c | 0.2 | c | 0.2 | c | 51.7 | bc | 144.3 | b | 174.2 | a | 270.1 | a |
| NCS10156 | 0.0 | b | 0.0 | b | 1.0 | ab | 6.9 | b | 4.4 | b | 11.5 | ab | 121.9 | a | 238.2 | a | 74.6 | a | 205.6 | a |
| Winter Dawn | 15.7 | a | 20.1 | a | 0.8 | b | 15.1 | a | 0.5 | bc | 3.4 | bc | 61.3 | b | 179.9 | ab | 78.5 | a | 171.9 | a |
| | <0.0001 | | <0.0001 | | 0.018 | | 2E-04 | | 0 | | 0 | | 0 | | 0 | | 0.1 | | 0.2 | |

Table 6. Field monthly yield breakdown NC A&T, Greensboro, NC.

| Monthly yield | Nov-Dec | | | | Jan-Feb | | | | March | | | | April | | | | May | | | |
|---------------|------------------|---|-------------|---|------------------|----|-------------|---|------------------|----|-------------|---|------------------|----|-------------|----|------------------|----|-------------|----|
| | Marketable Yield | | Total Yield | | Marketable Yield | | Total Yield | | Marketable Yield | | Total Yield | | Marketable Yield | | Total Yield | | Marketable Yield | | Total Yield | |
| Flavorfest | 0.0 | b | 0.0 | b | 0.0 | d | 0.0 | c | 1.2 | c | 4.7 | c | 106.5 | b | 207.2 | b | 100.5 | c | 238.9 | bc |
| Florida 127 | 0.8 | b | 12.4 | b | 10.6 | b | 66.9 | a | 29.1 | ab | 77.1 | a | 299.6 | a | 466.8 | a | 45.3 | c | 84.8 | d |
| Frontera | 1.2 | b | 2.0 | b | 3.8 | cd | 13.2 | c | 28.7 | ab | 43.1 | b | 369.7 | a | 585.8 | a | 214.4 | ab | 322.5 | b |
| NCS10038 | 0.0 | b | 0.0 | b | 1.5 | d | 3.6 | c | 2.8 | c | 5.1 | c | 383.0 | a | 530.9 | a | 315.5 | a | 487.5 | a |
| NCS10156 | 0.0 | b | 0.0 | b | 3.2 | d | 36.7 | b | 12.8 | bc | 39.9 | b | 317.4 | a | 489.1 | a | 65.0 | c | 135.6 | c |
| Winter Dawn | 18.6 | a | 40.4 | a | 28.7 | a | 78.8 | a | 46.7 | a | 86.7 | a | 222.1 | ab | 346.2 | ab | 139.8 | bc | 239.9 | bc |
| | 0 | | 0.006 | | <0.0001 | | <0.0001 | | 0 | | <0.0001 | | 0 | | 0.1 | | 0 | | 0 | |