

2005 PROGRESS REPORT
To
North Carolina Sweetpotato Commission

TITLE: Sweetpotato Grower-Participatory Breeding Project Support

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DEPARTMENT: Horticultural Science

REPORT:

Project Objective(s): The objectives of the Sweetpotato Breeding and Genetics Program are: 1) to develop sweetpotato varieties for North Carolina growers that possess exceptional yield, appearance, quality, and disease and insect resistance characteristics; and 2) to conduct basic and applied breeding and genetics studies focused on identifying and incorporating traits of economic importance into sweetpotato germplasm and new cultivars. The specific objectives of the Grower-Participatory Breeding Project (GPBP) are to work collaboratively with growers, Extension Agents and Specialists to evaluate seedlings, and preliminary and advanced selections of our most promising breeding lines on-farm with the goal of rapidly selecting and developing new varieties.

Project Cooperators

| <u>Extension Personnel</u> | <u>Growers</u> |
|----------------------------|-----------------------------|
| Mark Seitz | Kendall Hill |
| William Little | Sonny Scott |
| Allan Thornton | Roger Lane Pride of Sampson |

Project Summary:

The Grower-Participatory Breeding Project has been in existence for eight years and we now have two primary research objectives. First, we are continuing our efforts to grow and select first-year seedlings on commercial farms. Second, we are evaluating our most promising advanced lines on-farm so that growers can provide input on their commercial potential. Those that perform well can be rapidly increased by growers, and evaluated for field, storage and packing traits on a larger scale. Covington, released in 2005, is our first "graduate" of this system of breeding.

This collaborative effort has been very successful in that it has increased information exchange between growers, researchers and extension personnel. From a breeding perspective, it has also enabled us to better define our breeding goals and prioritize these based on input from growers. For growers, it has allowed us to demonstrate and explain how new cultivars are developed.

Table 1 provides a summary of the number of clones the GPBP has screened on-farm as part of the GPBP. To date, this project has resulted in the development of 20 advanced lines that are in various stages of evaluation, and six breeding lines that are being used in our polycross breeding nurseries.

Roughly 30% of the true seed grown in our breeding program during 2005 were grown on three farms with the cooperation of growers, Extension Agents and Specialists. Field sites were located within commercial fields and the trials were treated in the same fashion as the commercial fields (fertilizer, pest control etc., except spacing) (Table 2). From 15,000 seedlings planted, 330 were selected for further evaluation, a rate of 2.2%, slightly higher than the long-term average of 1.5%. Growing conditions varied from site to site, which is one of the strengths of this project. All sites yielded selections that had better appearance than the check variety Beauregard. This year we also included Covington as a check variety on the same three-foot spacing as the seedlings. We observed that Covington produces much better shapes and more uniform sizes than Beauregard does on a similar wide spacing.

Selection at harvest was based on the following subjective visual criteria: shape, flesh color, skin texture, relative yield, size distribution, root number, earliness, and observable diseases or defects. These selections will be planted in Clinton and Kinston in 2006 as unreplicated 20-hill plots for the second cycle of selection.

The second component of the GBBP is to evaluate promising breeding lines under commercial conditions. This year we planned for 14 clones and 4 check lines to be grown at each location in unreplicated 100-hill plots and evaluated at each location where the seedlings were grown. However, our plant beds in Clinton were considerably behind our seedlings, so our earlier plantings did not get all fourteen lines. Notes on how they performed at each location are shown in Tables 3-5. These observations are combined with research station trial data and disease screening data to determine the potential of each as a cultivar. Covington was clearly the best clone in these trials.

Performance of the different clones varied significantly from farm to farm (Tables 3-6). Indeed, observing differences in clonal "performance" from site to site has been very useful for our breeding efforts because it allows us to select those clones that are most stable from site to site, and season to season. For an example of this see Table 6 which compares the yield and appearance ratings of all the clones tested across each of the three sites. This table is not as robust as normal since many of the clones were only in one or two tests, but it is still useful especially where a clone performed unacceptably. Besides Covington only two of the advanced clones performed reasonably well in all grower locations. Their descriptions are as follows:

NC99-026 A moderately smooth, light copper-rose skin, orange fleshed clone that produces elliptic to blocky shapes. Lenticels a little prominent, generally short length/diameter ratio that makes for nice sized No.1 roots, early to mid season. Good size distribution and earliness.

Disease Resistances: Resistant to Fusarium wilt and root-knot nematodes. Moderately susceptible to soil rot.

Status: Advanced tests in 2006 and on-farm trials. Needs further screening for soil rot resistance. Skin color may be too light. Will use in 2006 polycross nursery.

NC99-573 This clone produces smooth skinned, rose-colored roots that are attractively shaped. Yield is high. Growing season about two weeks longer than Beauregard. Lenticels are fairly prominent in wet conditions and it is susceptible to root-knot nematodes. May have rows of moderately prominent eyes.

Disease Resistances: Resistant to Fusarium wilt and Streptomyces soil rot, susceptible to root-knot nematodes.

Status: Virus indexed. Will test clean plants in 2006. NC99-573 is a very good parent. We used it in our 2005 nurseries and will use again in 2006. Will be entered into National Sweetpotato Collaborators trial in 2006 and will initiate grower trials in 2007.

NC01-351 This is a tan skinned, orange-fleshed clone that produces very nicely shaped roots under most conditions. On-farm 2 this year is the first time shapes were not consistently nice. Significant cracking dropped the appearance score to 3 overall in this trial. Because of this it will only be considered for breeding.

Disease Resistances: Resistant to fusarium wilt, susceptible to root knot nematodes and soil rot

Status: In nursery in 2006.

Please see the Variety Development Report for yield trial results of these clones and performance of other advanced clones in the program. Many other lines performed well in only one or two of the sites

(Table 6), an indication that they are not broadly adapted.

When we are limited to testing on the research stations alone we typically do not see as many varied environments per season. Thus, the GPBP has enabled us to evaluate the performance of clones under a variety of stresses (e.g. drought, flooding, insect, disease and weed pressure) in a single year. If only a single evaluation site is available this process takes a few years, and we have to carry and increase lines that have serious weaknesses and this lengthens the time to release.

In addition to evaluating tablestock material in the on-farm trials, this year we included four high dry matter lines on On-farm 1 for evaluation, in four-row 1000 plant plots. Unfortunately, deer pressure at this site was very high, but enough material was obtained for evaluation of these clones as feedstocks for ethanol production. At the On-farm 2 and 3 sites, we included 45 and 8 purple-fleshed lines, respectively. We have made significant progress the last two years on anthocyanin levels and needed to determine how broadly adapted this material is. Most clones did not perform well, but a few did, and the notes collected here will help us decide which to use as parents for the next generation of crosses.

Our emphasis in 2006 will be on expanding the number of advanced materials evaluated in multiple locations so we can identify widely adapted materials and advance them as quickly and under as many environmental conditions in a single year as possible. We will also be adding more specialty-types in these evaluations as they become available.

Acknowledgements

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Table 1. Number of sweetpotato seedlings planted and number selected over successive years (1998-2005) from on-farm GPBP tests.

| Year | No. of true seed planted | No. of seedlings selected | No. of original seedlings remaining after 2 nd year | No. of original seedlings remaining after 3 rd year | No. of original seedlings at advanced evaluation stage | No. of original seedlings retained for breeding |
|--------|--------------------------|---------------------------|--|--|--|---|
| 2005 | 15000 | 330 | ---- | ---- | ---- | ---- |
| 2004 | 15000 | 186 | 18 | ---- | ---- | ---- |
| 2003 | 15000 | 157 | 24 | 11 | ---- | ---- |
| 2002 | 18000 | 251 | 10 | 7 | 3 | 2 |
| 2001 | 15000 | 153 | 22 | 5 | 1 | 0 |
| 2000 | 15000 | 303 | 24 | 7 | 5 | 1 |
| 1999 | 24000 | 260 | 47 | 10 | 7 | 1 |
| 1998 | 24500 | 358 | 22 | 9 | 4 | 2 |
| Totals | 141,500 | 1998 | 167 | 49 | 20 | 6 |

Table 2. Number of sweetpotato seedlings selected per female parent on-farm in 2005.

| Maternal parent | # selections | Maternal parent | # selections |
|---|--------------|-------------------------------------|--------------|
| <i>On-farm 1 - Pride of Sampson, seed from the 2004 Elite nursery</i> | | | |
| NC1528 | 5 | NC99-573 | 16 |
| NC96-27 | 12 | NC00-101 | 9 |
| NC97A-04 | 7 | NC00-677 | 6 |
| NC98-076 | 2 | Bienville | 13 |
| NC99-524 | 7 | NC C58 | 9 |
| | | Total | 86 |
| <i>On-farm 2 - Tull Hill Farm, seed from 2004 SSR Nursery</i> | | | |
| NC93-50 | 12 | Beauregard | 7 |
| NC97-433 | 28 | Bienville | 14 |
| NC98-576 | 15 | NC C58 | 17 |
| NC99-088 | 8 | L96-117 | 8 |
| NC01-351 | 15 | Tib 4 | 11 |
| | | Total | 135 |
| <i>On-farm 3 - Scott Farms</i> | | | |
| <i>2004 Elite nursery</i> | | <i>2004 SSR nursery</i> | |
| NC1528 | 6 | NC97-433 | 17 |
| NC99-573 | 13 | NC C58 | 2 |
| NC00-677 | 13 | | |
| NC00-101 | 1 | | |
| Ruddy | 45 | | |
| | | <i>2004 Elite and SSR nurseries</i> | |
| | | W250 | 12 |
| | | Total | 109 |
| | | On Farm Grand total | 330 |

Table 3. 2005 On Farm 1 Trial, Sampson Co. - Trait Data. Please see Keys to Tables section at the end of this report for descriptions to the abbreviations.

| CLONE | MAT | YLD | L/D | SKC | SKT | FL | EYE | LEN | SH | SHV | APP | Comments |
|--------------|-----|-----|-----|--------|-----|------|-----|-----|-----|-----|-----|--|
| Covington G2 | M | 7 | 1.5 | rs | sm | 3.25 | 7 | 7 | 2,5 | 6 | 6 | Short, chunky, ^ovate shapes |
| Hernandez | M | 7 | 2 | co or | ms | 3.5 | 6 | 8 | 3 | 6 | 6 | ^pimples, ^TP |
| NC99-026 | EM | 6 | 1.5 | rs/tan | sm | 3 | 7 | 8 | 2 | 6 | 5 | Round, ~size var., ~nice roots, low root set, FW? |
| NC99-573 | M | 6 | 1.5 | rs | sm | 3.25 | 7 | 7 | 3,6 | 4 | 4 | |
| NC01-351 | E | 7 | 2 | tan/or | sm | 3.5 | 8 | 7 | 6 | 7 | 7 | Nice size uniformity, g shapes, a few small sprts |
| NC01-362 | EM | 7 | 3 | lt rs | sm | 3.25 | 7 | 7 | 3,4 | 5 | 5 | ~crooks, ~FW? ~CR, L, CU |
| NC02-462 | M | 7 | 3 | red | sm | 3 | 8 | 8 | 3 | 5 | 5 | TP, RC, drop for RC + shapes |
| NC02-504 | E | 7 | 1.5 | rs | sm | 3 | 8 | 7 | 2 | 6 | 5 | ~CR on jum, v short/round, some nice shapes, low set |
| NC BON02-442 | M | 3 | 2 | red | sm | 2 | 6 | 7 | 3,6 | 7 | 3 | Few roots/hill, low set, ~GR, VN |

Comments: Field was a deep sand, considerable deer damage in parts of the field damaged several advanced clones and checks (e.g. Beauregard) and notes were not taken for them.

Table 4. 2005 On Farm 2 Trial, Lenoir Co. - Trait Data. Please see Keys to Tables section at the end of this report for descriptions to the abbreviations.

| CLONE | MAT | YLD | L/D | SKC | SKT | FL | EYE | LEN | SH | SHV | APP | Comments |
|------------------|-----|-----|-----|----------|-----|------|-----|-----|-------|-----|-----|---|
| Covington G2 | ME | 7 | 2 | rs | ms | 3 | 8 | 7 | 3,6 | 8 | 8 | g sh uniformity, blocky, few T, nice |
| B94-14 G2 | | | | | | | | | | | | More roots than Cov |
| Sandhills | M | 7 | 3 | rs | ms | 3 | 7 | 7 | 3,6 | 5 | 5 | |
| Hernandez G2 | M | 7 | 3 | co or | ms | 3.25 | 6 | 7 | 3,4,6 | 6 | 6 | Fair app, ~sprt ~CV, ^T, few roots/hill |
| NC99-026 | ME | 6 | 1.5 | lt co rs | sm | 3 | 7 | 7 | 2,3 | 7 | 5 | ~STR, ~IRR, ~CR, ^# roots |
| NC99-573 | ML | 7 | 3.5 | rs | ms | 3 | 8 | 8 | 3,6 | 7 | 6 | |
| NC00-720 | ML | 5 | 4 | rs | ms | 3 | 7 | 6 | 4 | 3 | 3 | Long + irr |
| NC01-214 | M | 6 | 2.5 | co rs | ms | 3 | 7 | 7 | 3 | 7 | 6 | ^T |
| NC01-351 | M | 6 | 2.5 | tan | sm | 3 | 7 | 7 | 3,6 | 4 | 3 | ^CR, ^T, ~strings |
| NC01-362 | EM | 7 | 2.5 | rs | ms | 3 | 7 | 7 | 3,6 | 5 | 5 | ~strings, few roots/hill |
| NC02-462 | ML | 6 | 3 | dk rs | sm | 3 | 8 | 7 | 3,4 | 6 | 5 | var sizes, ~TP |
| NC02-504 | ME | 6 | 1.5 | rs | sm | 3 | 8 | 8 | 2,3 | 6 | 6 | ~CR, S-RKN?, v short/round |
| NC BON02-442 | E | 6 | 3 | pu | sm | 1.5 | 6 | 8 | 3,6 | 6 | 5 | Few roots, B, ~GR |
| B94-14 G2 grower | ME | 7 | 3.5 | rs | ms | 3 | 8 | 7 | 3,6,7 | 5 | 5 | ~IRR, ^long, ~S PR, 1/10 |
| Carolina Ruby | ML | 6 | 3 | dk rs | ms | 3 | 7 | 5 | 7 | 6 | 4 | ^^long, ^IRR |

Comments: Covington stood out for appearance and size distribution.

Table 5. 2005 On Farm 3 Trial Wilson Co. - Trait Data. Please see Keys to Tables section at the end of this report for descriptions to the abbreviations.

| CLONE | MAT | YLD | L/D | SKC | SKT | FL | EYE | LEN | SH | SHV | APP | Comments |
|---------------------|-----|-----|-----|-------|-----|------|-----|-----|-----|-----|-----|---|
| Covington G2 | M | 8 | 2.5 | dk rs | ms | 3 | 7 | 7 | 6,3 | 8 | 8 | ~T, nice |
| NC99-026 | EM | 7 | 2 | lt co | sm | 3 | 8 | 8 | 3,6 | 7 | 6 | ~CV hills & roots, ^T, ~CU, |
| NC99-573 | ML | 7 | 3 | rs | ms | 3 | 7 | 8 | 3,4 | 6 | 5 | ~LT, ^#roots, ~VN, ~shapes |
| NC00-720 | ME | 7 | 3 | dk rs | ms | 3.5 | 7 | 8 | 3,6 | 6 | 5 | OK but not ^ of v nice roots |
| NC01-214 | M | 7 | 3 | co | ms | 3.25 | 8 | 8 | 3,6 | 6 | 6 | ^tapers, ^#roots, ~CU |
| NC01-334 | M | 7 | 2.5 | rs | ms | 3 | 8 | 8 | 3,6 | 6 | 4 | ~STR, ~T, ~curves |
| NC01-351 | EM | 8 | 2.5 | tan | sm | 3.5 | 8 | 8 | 3,6 | 7 | 7 | Very nice, ~T skin color OK? |
| NC01-362 | M | 8 | 3.5 | co | ms | 3.25 | 8 | 8 | 3,4 | 6 | 4 | Too long, ^#roots, ^TP, drop |
| NC02-121 | EM | 8 | 3 | co or | ms | 3 | 7 | 7 | 3,6 | 6 | 7 | ~PI, early, ^2ndary roots, ~long |
| NC02-260 | ML | 6 | 2.5 | co or | ms | 3.5 | 6 | 7 | 3 | 6 | 6 | ^#roots, ~T, ~c |
| NC02-404 | ML | 6 | 3 | dk rs | ms | 3 | 7 | 7 | 3 | 5 | 4 | urves |
| NC02-423 | M | 7 | 2.5 | rs | ms | 3.25 | 7 | 7 | 3 | 7 | 6 | ~T, ~IRR, ~STR |
| NC02-462 | L | 5 | 4 | red | sm | 3 | 7 | 8 | 4,7 | 6 | 3 | ~v nice shapes |
| NC02-504 | EM | 7 | 2.5 | rs | sm | 3.25 | 8 | 8 | 3 | 6 | 6 | Too late, ^junk |
| NC BON02-442 | EM | 6 | 3 | pu | sm | 1.5 | 6 | 8 | 3,6 | 5 | 5 | ~CR, ~TP, ~T ^CU & lumpy roots, ~T, ^skinning, OK for Boniato |
| B94-14 G2 Sandhills | M | 8 | 3 | rs | ms | 3 | 8 | 8 | 6,3 | 5 | 6 | ~L, ~CU, ~MSH |
| B94-14 G2 Grower | EM | 7 | 3 | rs | ms | 3 | 7 | 7 | 3,6 | 6 | 6 | ~T, ~L-IRR, ^ID |

Table 6. 2005 On Farm Trial Appearance and Yield ratings for all three sites.

| CLONE | Appearance rating | | | | Yield rating | | | |
|---------------------|-------------------|----------|----------|------------|--------------|----------|----------|------------|
| | Farm 1 | Farm 2 | Farm 3 | Avg | Farm 1 | Farm 2 | Farm 3 | Avg |
| Covington G2 | 6 | 8 | 8 | 7.3 | 7 | 7 | 8 | 7.3 |
| NC99-026 | 5 | 5 | 6 | 5.3 | 6 | 6 | 7 | 6.3 |
| NC99-573 | 4 | 6 | 5 | 5.0 | 6 | 7 | 7 | 6.7 |
| NC00-720 | | 3 | 5 | 4.0 | | 5 | 7 | 6.0 |
| NC01-214 | | 6 | 6 | 6.0 | | 6 | 7 | 6.5 |
| NC01-334 | | | 4 | 4.0 | | | 7 | 7.0 |
| NC01-351 | 7 | 3 | 7 | 5.7 | 7 | 6 | 8 | 7.0 |
| NC01-362 | 5 | 5 | 4 | 4.7 | 7 | 7 | 8 | 7.3 |
| NC02-121 | | | 7 | 7.0 | | | 8 | 8.0 |
| NC02-260 | | | 6 | 6.0 | | | 6 | 6.0 |
| NC02-404 | | | 4 | 4.0 | | | 6 | 6.0 |
| NC02-423 | | | 6 | 6.0 | | | 7 | 7.0 |
| NC02-462 | 5 | 5 | 3 | 4.3 | 7 | 6 | 5 | 6.0 |
| NC02-504 | 5 | 6 | 6 | 5.7 | 7 | 6 | 7 | 6.7 |
| BON02-442 | 3 | 5 | 5 | 4.3 | 3 | 6 | 6 | 5.0 |
| B94-14 G2 Sandhills | | 5 | 6 | 5.5 | | 7 | 8 | 7.5 |
| B94-14 G2 Grower | | 5 | 6 | 5.5 | | 7 | 7 | 7.0 |
| Carolina Ruby | | 4 | | 4.0 | | 6 | | 6.0 |
| Hernandez | 6 | 6 | | 6.0 | 7 | 7 | | 7.0 |

Keys to Tables

Storage root data: **MAT**=maturity E=early, M=mid and L=Late; **DM**=percentage dry matter; **L/D**=length/diameter ratio; **SKC**=skin color clr=clear cu=copper, lt=light, or=orange, pi=pink, pu=purple, rd=red, rs=rose, tn=tan wh=white; **SKT**= skin texture, m fl= moderate flakiness of skin, l fl= light flakiness to skin, ms=moderately smooth, sm=smooth; **FL**=flesh color (0-5 scale where 0=pure white, 1= cream, 2=yellow, 3= medium orange, 4=deep orange, 5= very deep orange; **EYE**=eyes(0-9); **LEN**= lenticels (0-9); **SH**=Shape (see diagram); **SHV**=shape variability(0-9); **APP**=overall appearance (0-9). All 0-9 scales go from low or poor to high or good.

Comment codes: **AT**=tough attachment; **B**=bumpy shapes; **BRD**=breeding only; **BSR**=bacterial soft rot; **CR**=cracking; **CRK**= crooked shapes; **CS**=circular spot; **CU**=curved roots; **CV**=skin color variation end to end; **D**=drop; **ESC**=Early season cracking; **EY**=deep eyes; **FB**=fleabeetle damage; **FS**=Fusarium root rot; **GR**=grooves; **HC**=horizontal constrictions; **ID**=unspecified insect damage; **IRR**=irregular; **JL**=jumbo's for length; **L**=long; **LE**=lenticels; **LG**=longitudinal grooves; **LR**=Lateral rings; **LT**=latex; **MSH**=misshapen roots; **NS**=nice shapes; **OV**=ovate or pear shapes; **PI**=pimples (0-9); **PN**=pencil roots; **PP**=pulled plants; **R**=rodent; **RC**=russet crack; **RG**=restaurant grade; **RH**=root hairs; **RKN**=root-knot nematodes; **RSK**=rough skin; **RT**=rot; **SD**=skin discoloration; **SH**=sheen; **SG**=string roots; **SK**=skinning; **SO**=souring; **SPR**=sprouts; **SR**=soft rot; **SS**=stays short; **SSR**=streptomyces soil rot; **STR**=Striations; **T**=tails; **TP**=tapered roots **VN**= veins; **SC**=scurf; **SF**=surface Fusarium; **WB**=whitefringed beetle; **WG**=white grub; **WW**=wireworm; **YCR**=yellow cortical ring; **YLD**=yield; **2°R**=secondary roots.

^ = lots, ~ = moderate, ↓ = little or poor

(Rating scale: 0 = very severe to 9 = absent)

Shapes

