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PROGRESS REPORT
To
North Carolina Sweetpotato Commission

TITLE: Sweetpotato Grower-Participatory Breeding Project Support

LEADERS: G. C. Yencho and K. V. Pecota

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 - 2008

Extension Personnel	**Growers**
William Little	Jones Farms, Nash County
Allan Thornton	Terrell and Johnny Williams Farms, Sampson County

Project Summary:
The Grower-Participatory Breeding Project has been in existence for ten years and we have two primary research objectives. First, we grow and select first-year seedlings on commercial farms. Second, we evaluate 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. NC99-573 now being released as 'Hatteras', has also passed through this system.

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 as well as test our clones in "real world" situations. 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 47 advanced lines that are in various stages of evaluation, and fourteen breeding lines that are being used in our polycross breeding nurseries.

Roughly 30% of the true seed grown in our breeding program during 2008 were grown on two 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, 267 were selected for further evaluation, a

rate of 1.8%, slightly above our long-term average. Soil types varied between sites, and both trials were planted during the first week of June when temperatures were in the 100's. This caused significant mortality at one location and is the main reason set and shapes were off in the advanced line trials. Our ability to evaluate the same lines under various conditions is one of the strengths of this project. We expect selections tolerant to hot establishment conditions to arise from these trials.

Selection of single-hill seedling plots 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 2009 as unreplicated 25-hill plots for the second cycle of selection.

The second component of the GPBP is to evaluate promising breeding lines under commercial conditions. This year we planted 24 clones and 7 check lines at each location in unreplicated 50-100-hill plots at each location where the seedlings were grown. 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. Hatteras (NC99-573) performed well at both trials, Covington at one site, while Beauregard was rough at both sites.

Performance of the different clones varied significantly from farm to farm (Tables 3-5). 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 5 which compares the yield, appearance and maturity ratings of all the clones across sites. Besides Hatteras, only four of the advanced clones performed reasonably well in all grower locations. Two of those, NC04-011 and NC04-086 have been discarded for again testing susceptible to Fusarium wilt. Descriptions of the other two follow:

NC04-531 - A rose skinned, deep orange-fleshed offspring of Ruddy. Elliptic shapes with very good shape uniformity. Good appearance characteristics. Good yield and 23% dry matter. Very good plant producer. Mid to late season. Excellent disease resistance. Has occasionally set too many roots to size.

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

Status: Using as a parent for disease resistance, shape characteristics, sprouting ability and higher dry matter. Further trialing in 2009 on station and on-farm.

NC05-284 - A copper skinned, orange-fleshed offspring of Evangeline. It has blocky to elliptic shapes with good shape uniformity. Dry matter is low at 16% (Beauregard averages 18% in NC, Covington 19%), Yield is good, though not as consistent as Covington. Sets relatively few roots and sizes them early.

Disease Resistances: Resistant to root-knot nematodes, moderately resistant to soil rot, may be susceptible to fusarium. Needs further screening.

Status: Further trialing in 2009 on station and on-farm.

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 5), 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 table-stock material in the on-farm trials, this year we included three Boniato type clones, one of which did fairly well in both locations and twelve purple-fleshed clones. Two of the purple-fleshed clones performed fairly well in both locations, but are both still long season clones. We still have considerable work to do to bring them to the level of yield and appearance of the table-stock lines. This is not a particularly fair test for them since most are also high dry matter lines, which also makes them late since time is needed to produce the extra starch. The on-farm trials are dug when the three foot wide spaced seedling are ready, which is usually a bit early for the table-stock lines, and very early for higher dry matter material. Notes collected here will help us decide which purple-fleshed clones to use as parents for the next generation of crosses.

Our emphasis in 2009 will be on continuing the evaluation of advanced materials 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, including purple-fleshed lines and clones suitable for chips and fries.

Acknowledgements

The continued support of the NC SweetPotato Commission is gratefully acknowledged. The exceptional technical expertise and assistance of Jarred Driscoll, Ben Winslow Meri Reeber and Mark Clough, Research Technicians and Researcher with the sweetpotato and potato breeding programs, respectively is acknowledged. We also thank the research station staff at the HCRS, CCRS and CRS, and Peyton Peterson and Blake Bowen our summer helpers for excellent support, and Graduate Student Per McCord, for their assistance during the year.

Table 1. Number of sweetpotato seedlings planted and number selected over successive years (1998-2008) from on-farm GPBP tests.

Year	No. of true seed planted	No. of seedlings selected	No. of original seedlings remaining after 2nd year	No. of original seedlings remaining after 3rd year	No. of original seedlings at advanced evaluation stage	No. of original seedlings retained for breeding
2008	15000	267	----	----	----	----
2007	15000	279	47	----	----	----
2006	15000	204	24	13	----	----
2005	15000	330	37	18	11	2
2004	15000	186	18	8	7	2
2003	15000	157	24	11	9	2
2002	18000	251	10	7	3	4
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	186,500	2748	275	88	47	14

Table 2. 2008 Sweetpotato seedlings selected on farm.

Maternal parent	No. of selections	Maternal parent	No. of selections
Jones Farms, seed from the 2007 SSR nursery			
NC 96-61	6	NC 02-350	7
NC 97A-45	6	NC 02-423	6
NC 99-026	10	NC 02-459	6
NC 99-573	30	NC 03-030	9
NC 00-720	3	Murasaki-29	10
NC 00-748	3	Ruddy	14
NC 01-156	6	Tib 4	14
		Total	**130**
Williams Farms, seed from the 2007 Elite nursery			
NC C58	13	NC 01-156	6
NC 96-61	7	NC 01-214	6
NC 97A-04	21	NC 03-380	5
NC 97A-45	17	Evangeline	14
NC 97-433	10	L95-95	7
NC 99-026	10	Ruddy	13
NC 99-573	8		
		Total	**137**
		On Farm Grand total	**267**

Table 3. 2008 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
B94-14 G2	E	7	3.5	rs	sm	3	8	7	3,5,6	4	4	Few roots/hill
B94-14 G1	E	7	3.5	rs	sm	3	8	7	3,5,6	4	4	^Irr, bumpy
Covington G2	EM	7	2	co rs	ms	3	7	6	6	7	7	Chunky, ~rnd
Covington G1	EM	7	2	co rs	ms	3	7	6	6	7	7	Chunky, ~rnd
NC99-573 G2	E	7	2.5	rs	sm	3	7	7	3,6	7	7	Few Irr, ^latex stains
NC99-573 G1	E	7	3	rs	sm	3	7	7	3,6	6	7	~Irr, ^latex stn mixed sizes
03-066	L	4	3	org	ms	3.25	7	5	3,6	5	3	~cracks
03-311	L	6	3	co org	sflk	3.25	7	7	3	6	6	~Pi's
04-011	ML	6	2.5	rs	ms	3.25	7	7	6,3	6	5	~T,~Irr,tapers
04-069	M	5	3.5	lt rs	sm	2.75	5	6	3,6,5	4	4	^Irr,ycr, tapers
04-086	M	7	2.5	co or	sm	3	7	7	3,6	7	6	^CR, drop
04-090	ML	5	3	pur	sm	2.75	7	6	3,6		5	~latex,T, ↓ yld
04-120	ML	6	3	rs	ms	3.25	6	7	6,3	5	5	^CRV,tapers, drop?
04-165	L	4	3	pur	ms	2.75	7	7	3,7	4	3	↓yld+shape,D
04-531	ML	6	3	rs	ms	3.25	7	7	3	6	6	
05-198	E	7	3.5	rs	sflk	3	7	6	3,6	6	6	↓roots, long
05-284	M	7	3	co	ms	3	7	6	3,6	7	7	T, sweet raw, low DM?
Boniato's												
05-408	EM	7	2	wh	sm	2	7	4	2,6	6	5	~FW,~VN,~T, few roots
05-589	M	6	3	wh	ms	2	7	6	3,6	6	5	~T, low set
DM05-156	ME	6	3	wh	sm	1.5	7	7	3,6	5	4	^CRK
Kotobuki	L	3	3.5	pur	sm	1.5	6	7	3,4	6	4	Little here
Murasaki-29	L	4	3	pur	ms	1.5	7	7	3	5	4	
Purple Flesh												
NC413	M	6	3.5	pur	ms	P3	7	5	3	5	3	^VN,^GR,AT, ~2^0rts
Pur05-028	ML	4	3	pur	sm	P3.5	7	7	3	6	4	^^VN,~GR
Pur05-055	L	4	3.5	pur	sm	P3.5	7	7	3,7	3	4	~CR
Pur05-063	L	3	4	pur	ms	P4	7	7	3	5	3	~Spr,^T,^CRV
Pur05-086	L	2	1.5	pur	ms	P4	7	7	2,3	6	2	S-SSR? drop
Pur05-095	L	4	3	pur	sm	P3	7	7	6,3	6	5	~VN
Pur05-100	L	3	2.5	pur	ms	P3.5	7	6	3	5	3	^VN,^GR, ~2^0rts
Pur06-014	L	4	4	pur	ms	P3.5	7	7	4,7	5	4	L,~GR,tapers
Pur06-016	L	4	3	pur	ms	P3.5	7	7	3	6	4	~VN,~T
Pur06-020	L	4	3	pur	ms	P3.5	7	7	3	4	4	~Spr,^VN
Pur06-028	M	5	3	pur	sm	P2nu	7	5	3	6	5	
Pur06-048	M	6	3	pur		P3.5	7	6	3	6	5	~CR, S-RKN?
Pur06-061	M	6	2.5	pur	ms	P3	7	7	3	6	5	

Comments: Hot and dry early but stands were good, overall a good site. Covington, NC99-573 and NC05-284 had the best overall appearance.

Table 4. 2008 On Farm 2 Trial, Nash 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
B94-14 G2	EM	6	3.5	rs	sm	3	8	8	3,7	3	2	
Covington G2	M	3	2	rs	ms	3	7	6	3,7	3	3	VN,AT, some ESC
NC99-573 G2	E	7	2.5	rs	sm	3	7	5	3,6	6	6	
03-066	ML	4	3	co org	sm	3	7	7	3,7	4	3	^^CR,~ESC
03-311	M	4	2	rs	sm	3	5	6	3	4	3	~CR
04-011	M	6	2	co org	sm	3	5	6	6,5	6	5	~SPR
04-069	L	3	3.5	lt rs	ms	2.75	6	6	7,3	3	2	^CR
04-086	M	6	3	co org	ms	3	7	6	3,5	5	5	^AC,^tapers
04-090	M	4	2.5	pur	sm	2.75	7	7	3,6	4	3	~bumpy, mix size +shapes
04-120	ML	4	2.5	rs	sm	3.25	7	7	3,7	4	4	^tapers
04-165	ML	4	3	rs	sm	3	7	7	3,7	3	2	^junk
04-531	L	5	3	rs	ms	3	7	5	5	5	5	~strings
05-198	M	4	3.5	rs	ms	3	7	7	7,3	3	2	^VN,^CR
05-284	EM	5	3	co org	ms	3	7	7	6,3	5	4	^T~VN,few rts
Boniato's												
05-408		5	2	wh	sm	2.5	7	5	3,2	4	3	~VN,chunky, hints orange fl
05-589	M	5	2	wh	sm	2	7	7	3	5	6	~VN,nice AT
DM05-156	L	5	3	wh	sm	2	7	6	6,3,7	3	3	CR,~inf LE's
Kotobuki	ML	4	3	lt rs	sm	2	7	7	3,7	4	4	~junk hills, ~strings
Murasaki-29	VL	2	2	pur	sm	1.5	7	7	3	3	2	
Purple Flesh												
NC413	L	3	3.5	pur	ms	P2.5	7	5	3,6	5	3	~SPR,~VN
Pur05-028	L	2	2	pur	ms	P3	7	7	2	4	3	^2^0rts
Pur05-055	LM	5	3	pur	sm	P3	7	7	6,3	7	6	~SPR, best of purples
Pur05-063	L	3	3.5	pur	ms	P4	7	7	3	3	2	^^VN,^^SPR, ^AT
Pur05-086	L	1	3	pur	ms	P3.5	7	7	2	3	1	No yld, ^mort, ^^AT,^SPR
Pur05-095	L	1	3	pur	ms	P2	---	---	3,7	3	1	Strings, ^^VN
Pur05-100	L	2	3	pur	sflk	P3	7	7	3	4	2	^VN,^^2^0rts, ^strings
Pur06-014	L	2	3.5	pur	sflk	P3.5	7	6	3	3	2	^GR,^CRK, ^junk
Pur06-016	LM	2	3.5	pur	sm	P3	7	7	3,7	3	2	^Irr,^2^0rts,^AT
Pur06-020	L	2	3	pur	sflk	P3.5	6	5	6,3	5	4	^SPR, ^AT
Pur06-028	L	1	3	pur	ms	P2	7	7	3,7	3	1	^^AT,^2^0rts
Pur06-048	L	4	2.5	pur	sm	P3	7	7	3,6,7	6	5	
Pur06-061	L	2	3.5	pur	ms	P2 nu	7	7	3,7	---	2	^CR, ^junk

Comments: Very hot and dry during and for the next week after planting which caused high mortality, rough shapes and veins. A very tough site even for established cultivars.

Table 5. 2008 On Farm Trial Appearance and Yield and Maturity ratings.

	Appearance rating		Yield rating		Maturity	
CLONE	Farm 1	Farm 2	Farm 1	Farm 2	Farm 1	Farm 2
B94-14 G2	4	2	7	6	E	EM
Covington G2	7	3	**7**	**3**	EM	M
NC99-573 G2	7	6	7	7	E	E
03-066	3	3	4	4	L	ML
03-311	6	3	6	4	L	M
04-011	5	5	6	6	ML	M
04-069	4	2	5	3	M	L
04-086	6	5	7	6	M	M
04-090	5	3	5	4	ML	M
04-120	5	4	6	4	ML	ML
04-165	3	2	4	4	L	ML
04-531	6	5	6	5	ML	L
05-198	6	2	7	4	E	M
05-284	7	4	7	5	M	EM
Boniato's						
05-408	5	3	7	5	EM	
05-589	5	6	6	5	M	M
DM05-156	4	3	6	5	ME	L
Kotobuki	4	4	3	4	L	ML
Murasaki-29	4	2	4	2	L	VL
Purple Flesh						
NC413	3	3	6	3	M	L
Pur05-028	4	3	4	2	ML	L
Pur05-055	4	6	4	5	L	LM
Pur05-063	3	2	3	3	L	L
Pur05-086	2	1	2	1	L	L
Pur05-095	5	1	4	1	L	L
Pur05-100	3	2	3	2	L	L
Pur06-014	4	2	4	2	L	L
Pur06-016	4	2	4	2	L	LM
Pur06-020	4	4	4	2	L	L
Pur06-028	5	1	5	1	M	L
Pur06-048	5	5	6	4	M	L
Pur06-061	5	2	6	2	M	L
Means	4.7	3.2	5.3	3.6		

Keys to Tables

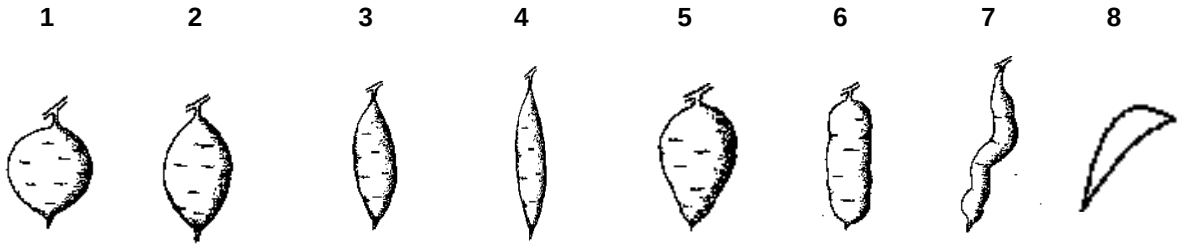
Storage root data: **MAT**=maturity E=early, M=mid and L=Late; **DM**=percentage dry matter; **L/D**=length/diameter ratio; **SKC**=skin color clr=clear cu=copper, lt=light, or=orange, pi=pink, pu=purple, rd=red, rs=rose, tn=tan wh=white; **SKT**= skin texture, m fl= moderate flakiness of skin, l fl= 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: **AC**=air cracking; **AT**=tough attachment; **B**=bumpy shapes; **BL**=blocky shapes; **BON**=Boniato type; **BRD**=breeding only; **BSR**=bacterial soft rot; **CR**=cracking; **CRK**= crooked shapes; **CRV**= curved roots **CS**=circular spot; **CV**=skin color variation end to end; **D**=drop; **ESC**=Early season cracking; **EY**=deep eyes; **FB**=fleabeetle damage; **FS**=Fusarium root rot; **G**=Geotricum; **GR**=grooves; **HC**=horizontal constrictions; **ID**=unspecified insect damage; **IR**=insect resistance; **IRR**=irregular; **JL**=jumbo's for length; **L**=long; **LE**=lenticels; **LG**=longitudinal grooves; **LR**=Lateral rings; **LT**=latex; **MSH**=misshappen roots; **NS**=nice shapes; **OV**=ovate or pear shapes; **PD**=Plectris damage; **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; **RND**=round; **RSK**=rough skin; **RT**=rot; **SC**=scurf; **SD**=skin discoloration; **SF**=surface Fusarium; **SG**=string roots; **SH**=sheen; **SK**=skinning; **SO**=souring; **SPR**=sprouts; **SR**=soft rot; **SS**=stays short; **SSR**=streptomyces soil rot; **STR**=striations; **T**=tails; **TP**=tapered roots; **TS**=tea staining; **VN**= veins; **WB**=whitefringed beetle; **WG**=white grub; **WW**=wireworm; **YCR**=yellow cortical ring; **YLD**=yield; **2^{o}R**=secondary roots.

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

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

Shapes



FUNDS SPENT (2008): NCARS/NCCES CODE 00-02

FUNDS SPENT	YEAR (2008)	YEAR (2009)	YEAR (2010)
EPA Salaries (Inc. fringe benefits)			
EPA-GRA Stipends			
Termination Date			
SPA Salaries (Inc. fringe benefits)	3,000	7,000	9,000
Part-time Labor (Inc. soc. sec. benefits)			
Supplies	2,500	2,500	2,500
Equipment (greater than $5,000)			
Travel	2,500	2,500	2,500
Other (Publication costs, etc)			
TOTAL (REQUESTED)	$ 10,000	$ 12,000	$ 14,000
TOTAL (DISBURSED AND SPENT)	$ 8,000		

IMPACT STATEMENT: NCARS/NCCES Code 00-02

The Grower Participatory Breeding Project supported by these funds has enabled the sweetpotato Breeding and Genetics program to continue our on-farm breeding activities, and to maintain a very high and productive level of interaction with growers and extension agents. This interaction is key to the long-term success of our program, and it has already led to the development of improved sweetpotato varieties for NC's growers, such as the variety Covington, which will occupied roughly 3/4 of NC's acreage in 2008, and most recently, NC99-573, which was released as the variety Hatteras in Nov. 2008. To date, support from this project has enabled us to evaluate over 186,500 seedlings on-farm. Forty-seven of these have attained advanced status. Additional conventional and specialty-type clones are either being increased for variety evaluation in replicated research station and on-farm trials for further evaluations, or are being used as superior parents in our breeding nurseries.