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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 evaluate seedlings, and preliminary and advanced selections of our most promising breeding lines on-farm, and to select and advance these lines to commercial production as quickly as possible by working collaboratively with growers, Extension Agents and Specialists.

Project Cooperators - 2009

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 twelve 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. Hatteras, has also passed through this system but it has been found to have serious flaws (internal break down in storage and excessive latex production), which several seed growers helped to uncover before it was place in wide-scale production.

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 54 advanced lines that are in various stages of evaluation, and 16 breeding lines that are or have been used in our polycross breeding nurseries and in paired crosses.

Roughly 30% of the true seed grown in our breeding program during 2009 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 13,640 seedlings planted, 439 were selected for further evaluation, a rate of 3.2%, double our long-term average. The 2009 season was an exceptional season for selections for the program as we selected more seedling this season than ever before. Planting and growing conditions were good for both trials with low mortality. Plants were produced in the new Horticultural Crops Research Station greenhouses, which provide good hardening off capabilities, a factor in plant quality. Soil types were both deep sands, but with different subsoils and depth to water table. Deer did some damage in one location but only affected one corner of the plot.

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 2010 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 28 clones and 4 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 and Beauregard performed well at both trials; Covington was particularly attractive at one site, at the second site Covington was very round.

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 and Beauregard only four of the advanced clones performed reasonably well in both grower locations. One of those, NC05-284 has been discarded for twice testing susceptible to Fusarium wilt. Descriptions of the other three follow:

NC05-257 – A dark rose moderately smooth-skinned, deep orange-fleshed offspring of Hernandez. It is mid season and high yielding. Shapes are elliptic and blocky, many with a slight curve from a moderately tight hill. Hills, shapes and root number are similar to Hernandez. Eyes are moderately deep. 19% dry matter (Beauregard averages 18% in NC, Covington 19%). Good chipping ability. Good plant producer in beds.

Disease Resistances: Moderately resistant to fusarium and soil rot, and moderately susceptible to root-knot nematodes. Will be screened another year.

Status: Further trialing in 2010 on station and on-farm; in 2009 Tablestock/Processing breeding nursery.

NC06-226 – A rose colored, moderately smooth-skinned, light orange-fleshed offspring of Evangeline. It is a mid to early season, high yielding clone. Shapes are blocky and elliptic and usually very consistent. Flesh color is a bit weak. 18% dry matter.

Disease Resistances: Resistant to fusarium, moderately susceptible to soil rot and root-knot nematodes. Will be screened another year, and if still susceptible to soil rot, dropped.

Status: Further trialing in 2010 on station and on-farm.

NC06-524 – A light orange, smooth-skinned, orange-fleshed offspring of Hatteras. It is mid to early season and high yielding. Shapes are elliptic, blocky with some ovoids. Roots are attached very lightly to the vines. Typically it has a moderate root set with good sizing. 16% dry matter.

Disease Resistances: Moderately resistant to fusarium, resistant to soil rot, and susceptible to root-knot

nematodes. Will be screened another year.

Status: Further trialing in 2010 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 as stable as desired.

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 five white-fleshed clones, none of which did well in both locations. We continue to look for a replacement for O'Henry that has the disease resistance and yield of O'Henry, but a higher packout and the culinary qualities of the older white varieties. We also included four purple- fleshed clones and our purple check, NC413. We have improved the yield and appearance of the purples considerably, but are still working to incorporate good levels of disease resistance and better eating quality. The on farm trials are a difficult trial for them since most are also high dry matter lines, which also makes them late since time is needed to produce the extra starch. Also, 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 2010 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 continue to screen 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 Austin Zanella our summer helpers for excellent support, and Graduate Student Blake Bowen, for their assistance during the year.

Table 1. Number of sweetpotato seedlings planted and number selected over successive years (1998-2009) from on-farm GPBP tests.

Year	No. of true seed planted on-farm	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
2009	13640	439	----	----	----	----
2008	15000	267	22	----	----	----
2007	15000	279	47	5	----	----
2006	15000	204	24	13	7	2
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	200,140	3187	297	93	54	16

Table 2. 2009 Sweetpotato seedlings selected on farm.

Maternal parent	No. of selections	Maternal parent	No. of selections
Jones Farms, seed from the 2008 SSR nursery			
NC 93-17	17	NC 04-412	4
NC 01-156	3	NC 05-408	24
NC 02-350	8	Hatteras	15
NC 02-459	9	Murasaki-29	14
NC 03-030	27	Ruddy	10
NC 03-302	11	TIS 70683	6
NC 04-090	7		
		Total	**155**
Williams Farms, seed from the 2008 Elite nursery			
NC 1528	13	NC 02-423	20
NC 96-61	21	NC 02-459	8
NC 97-433	17	NC 03-066	19
NC 97A-45	31	NC 03-380	5
NC 99-026	30	Evangeline	22
NC 99-524	9	Hatteras	25
NC 01-156	27	Ruddy	12
NC 01-214	12	Tib 4	13
		Total	**284**
		On Farm Grand total	**439**

Table 3. 2009 On Farm 1 Trial, William's Farm, 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
Table stock												
B94-14 G2	M	6	3	rs	ms	3	7	7	6	5	6	~IRR,~CRK, mostly good
Covington G2	M	6	3	rs	ms	3	7	7	6	7	7	nice
Hatteras G2	M	8	2.5	rs	ms	3	7	7	6,2	7	8	Exc sh +sz dist,^LT
04-032	M	5	4	rs	ms	3	7	7	3,6	6	5	L,TP
04-531	ML	5	4	rs	ms	3	7	7	3	6	5	L,~banding
05-106	M	7	2.5	rs	ms	3	8	7	3,6	6	6	chunky, 1 CR
05-108	ML	6	2.5	dk pi	ms	3	7	7	3	5	5	TP,~CRK
05-198	M	7	4	cu rs	ms	3	8	7	6,4	6	5	~IRR,L, mix of sizes
05-257	ML	7	2.5	dk rs	ms	3	6	6	3,6	7	7	~LT,7-10 rts/hill
05-284	M	7	3	cu	ms	3	7	7	6,3	7	7	G shape+sz uni
05-431	L	4	3	rs	ms	3	8	7	3	7	4	Late,low yld
05-528	M	6	3	lt or	ms	3	8	8	3	5	4	~spr,^TP,^AT,T
05-553	EM	7	4	rs	ms	3.25	8	6	4,3	4	4	poor sh,L,STR
06-037	M	6	3	rs	ms	3	8	7	6,3	5	5	flesh weak, ~shapes
06-185	M	6	3	dk rs	sflk	3.25	7	8	6,3	7	6	~SPR
06-226	ME	8	2.5	rs	sflk	2.75	7	6	6,3	8	8	vn shapes, ^yld
06-327	M	7	3	rs	ms	3.25	8	8	3	6	6	G in 6 rts in plot
06-524	ME	7	3	lt or	ms	3	8	7	3	7	6	exc AT, n shapes
06-546	ME	6	2.5	rs pi	sm	3	8	7	3,2	6	6	mix of L + short
06-557	ML	6	2	rs	ms	3	8	8	3,5	5	5	8-12 rts/hill, some v short
06-619	EM	8	3	rs	sm	2.75	7	7	3,4	5	5	OK sh, few nice
06-621	L	4	4	dk rs	ms	3.25	7	7	4,3	7	3	Drop?
Specialty												
03-302	E	7	2	rs pi	ms	1.5	8	7	2,3	6	5	~SPR,~ESC, ^AT,~T
05-589	ML	5	4	cr	ms	2	7	5	6,3	5	4	~LT,^LE's
06-183	M	6	2	cr	sm	1.75	8	7	3	6	5	^T, hints or in fl
06-345	L	4	3.5	w	ms	1.75	8	8	4,7	4	3	hints of pur in fl, D?
06-503	VL	4	4	w	ms	1.75	8	8	7,4	4	2	D
O'Henry	ML	7	3.5	w	sm	2	8	8	3,4	4	4	L,late,~IRR
Purple Flesh												
NC413	L	4	4.5	dk pur	ms	P3	7	7	6	5	4	L,~GR, too late
Pur06-002	ME	7	2.5	pur	ms	P2.5	8	7	6	7	7	nice shapes
Pur06-016	ML	5	4	dk pur	ms	P3	8	7	6,4	6	4	too long
Pur06-048	M	6	3	dk pur	ms	P3	8	6	6	7	7	n sh + clr for pur
Pur06-061	M	5	3	dk pur	ms	P2	7	6	6,3	6	6	color not uniform

Comments: Good stands and a good growing season. Soil was a deep moderately coarse sandy loam. Hatteras and NC06-226 had the best overall appearance, and two purple flesh lines scored well for appearance and yield.

Table 4. 2009 On Farm 2 Trial, Jones Farm, 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
Table stock												
B94-14 G2	E	7	2	rs	ms	3	7	7	6,3	7	6	v chunky, ~RND
Covington G2	M	6	1.5	cu rs	ms	3	7	6	2	7	4	too short
Hatteras G2	E	7	1.5	rs	ms	3	8	8	2	7	6	~spr, ^RND
04-032	E	8	3	rs	sm	3	8	8	6,3	7	7	~2^{0}rts
04-531	ML	6	2.5	rs	ms	3	8	6	3,2	6	6	~angular rings,~TP
05-106	M	6	3	rs	ms	3	8	6	3	5	4	^T,~SPR,~CRK, D?
05-108	L	6	2.5	rs	ms	3	7	7	3,2	4	4	^RC, D
05-198	ME	7	2.5	rs	ms	3	7	7	3,6	5	4	T,TP
05-257	E	8	2.5	rs	sm	3	7	7	6,2	6	6	~inf LE, ~2^{0}rts, ~TP,Hern like, tight hills,^rts
05-284	M	7	2	lt cu	ms	3	8	6	6	7	7	^nice roots
05-431	ML	7	3	cu rs	sm	3.25	8	8	6,3	6	6	^TP, w/ some v nice rts
05-528	L	7	1.5	tan	ms	3.5	8	8	2	7	4	short,^T,AT,D?
05-553	M	7	2	rs	ms	3	7	6	3	6	5	~SPR,^TP,D?
06-037	M	7	3	rs	ms	2.75	7	7	3,7	4	3	^SPR,~GR,D
06-185	ML	7	3	dr rs	ms	3.25	7	7	3	6	5	~VN,^TP,too many rts/hill?
06-226	M	6	2.5	lt rs	ms	2.75	7	6	3,6	6	6	
06-327	M	7	2.5	lt rs	ms	3	7	6	3,5	4	4	~2^{0}rts,^TP,^CRK
06-524	E	8	2.5	lt cu	sm	3	8	8	3,6	6	6	nice AT, ^yld
06-546	L	4	1.5	dk rs	sm	3	7	7	2	6	3	low yld,^OV,D
06-557	M	6	1.5	rs	ms	3	8	8	2,3	6	6	RND,chip line?, ~T,mix?,^petite
06-619	L	6	3	rs	ms	2.75	8	8	3	6	3	p sh, ^TP,CRK
06-621	L	4	3	rs	ms	3.25	8	8	3	5	5	Late,~T,↓yld,D
Evangeline	E	7	1.5	rs	ms	4	8	7	3,6,2	4	4	^RND,mix sh, ~AT
Specialty												
03-302	ML	7	2	rs	ms	1.75	8	7	3,2	6	5	~AT,~SPR,~T, ~short
05-589	M	6	2.5	cr	ms	2	7	6	3	7	6	~AT,~VN,~2^{0}rts ,D -unk disease
06-183	L	6	2	cr	sm	2	7	6	3,2	5	4	~TP,T,RND
06-345	M	6	2.5	tn	ms	2	8	8	3	6	5	~T,^TP,^petites
06-503	EM	7	2.5	cr	ms	2	7	6	3,6	7	6	~LE, nice white
Murasaki-29	L	6	2	pur	ms	1.75	7	7	3,6	6	6	~AT
Purple Flesh												
NC413	M	5	3	pur	ms	P2	7	5	3,6	6	4	AT,^VN
Pur06-002	ML	5	2	pur	ms	P2	8	8	3,6	6	4	^AT,few rts, ~SPR,~2^{0}rts
Pur06-016	M	5	3	pur	ms	P2.5	8	7	6,3	7	5	~AT,~nice sh
Pur06-048	M	5	2.5	pur	ms	P3	7	7	6,3	6	5	~2^{0}rts,low yld, AT~vn shapes
Pur06-061	M	6	3	pur	ms	P2	7	7	3	6	5	~nice shapes

Comments: A good season in a sandy soil that varied from end to end. In the very deep sand Hatteras and Covington were almost round. Yields and length improved as soil got heavier.

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
Orange Flesh						
B94-14 G2	6	6	6	7	M	E
Covington G2	7	4	6	6	M	M
Hatteras G2	8	6	8	7	M	E
04-032	5	7	5	8	M	E
04-531	5	6	5	6	ML	ML
05-106	6	4	7	6	M	M
05-108	5	4	6	6	ML	L
05-198	5	4	7	7	M	ME
05-257	*7*	*6*	*7*	*8*	*ML*	*E*
05-284	*7*	*7*	*7*	*7*	*M*	*M*
05-431	4	6	4	7	L	ML
05-528	4	4	6	7	M	L
05-553	4	5	7	7	EM	M
06-037	5	3	6	7	M	M
06-185	6	5	6	7	M	ML
06-226	*8*	*6*	*8*	*6*	*ME*	*M*
06-327	6	4	7	7	M	M
06-524	*6*	*6*	*7*	*8*	*ME*	*E*
06-546	6	3	6	4	ME	L
06-557	5	6	6	6	ML	M
06-619	5	3	8	6	EM	L
06-621	3	5	4	4	L	L
Specialty						
03-302	5	5	7	7	E	ML
05-589	4	6	5	6	ML	M
06-183	5	4	6	6	M	L
06-345	3	5	4	6	L	M
06-503	2	6	4	7	VL	EM
Purple Flesh						
NC413	4	4	4	5	L	M
Pur06-002	7	4	7	5	ME	ML
Pur06-016	4	5	5	5	ML	M
Pur06-048	7	5	6	5	M	M
Pur06-061	6	5	5	6	M	M
Means	5.3	5.0	6.0	6.3		

Italicized lines are ones performing well in both locations.

Keys to Tables

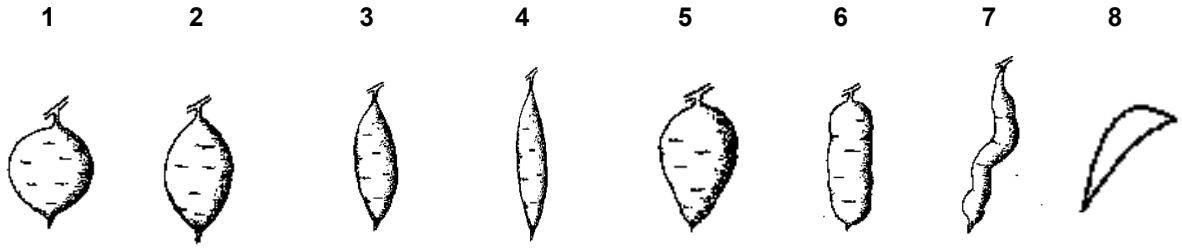
Storage root data: **MAT**=maturity E=early, M=mid and L=Late; **DM**=percentage dry matter; **L/D**=length/diameter ratio; **SKC**=skin color clr=clear cu=copper, lt=light, or=orange, pi=pink, pu=purple, rd=red, rs=rose, tn=tan wh=white; **SKT**= skin texture, m fl= moderate flakiness of skin, l fl= 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°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)		3,600	
EPA-GRA Stipends			
Termination Date			
SPA Salaries (Inc. fringe benefits)	3,000	1,500	9,000
Part-time Labor (Inc. soc. sec. benefits)		1,500	
Supplies	2,500	1,190	2,500
Equipment (greater than $5,000)			
Travel	2,500	210	2,500
Other (Publication costs, etc)			
TOTAL (DISBURSED AND SPENT)	$ 8,000	$ 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 occupied roughly 90% of NC's acreage in 2009. To date, support from this project has enabled us to evaluate over 200,000 seedlings on-farm. Fifty-four of these have attained advanced status. Many of these are either being increased for variety evaluation in replicated research station and on-farm trials for further evaluations, and/or are being used as superior parents in our breeding nurseries. On farm evaluation of advanced and preliminary lines has accelerated and improved our decision-making ability and confidence in releasing new cultivars.