

Sweetpotato Research Progress Report 2014

Scott Stoddard
Farm Advisor, Merced and Madera Counties

University of California Cooperative Extension

2145 Wardrobe Ave.

Merced, CA 95341

(209) 385-7403

<http://cemerced.ucdavis.edu>



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Sweetpotato Collaborators Trial -- 2014

Scott Stoddard, UCCE Merced County

This year's sweetpotato evaluation was with Quail H Farms, south of Livingston, CA. Soil type was Delhi sand, slightly saline. Conventional field, fumigated with Telone prior to planting. Drip irrigated, water quality marginal - high salts & alkalinity. Record dry winter and spring but good stand establishment. L-09-149 had only 2 reps because of limited plants in bed. Two row plots, machine harvested and sorted by grower crew. Very few culls this year. Good overall yields.

Rep	Var#	Variety Name	Skin Color	Skin Text	Flesh color	Eyes	Lents	Shape	Uniform	Overall App	Comments	notes on culls
1	1	Covington	Rose-Cu	9	3	7	3	2,3	7	9	Good color and skin texture & shape.	cuts
2											1 tip rot, lenticles, LG	
1	2	Cal Bx G1	Rose	5	4	9	7	2,3,5	6	8	Slightly less rosy than Cov.	RC, RKN
2					3						Some RC & rough skin	
1	3	175 G1	maroon	9	4	9	7	1,2,6	7	8	a few veins, not quite as red as Diane. Chunky.	
2					5							
1	4	Diane	red	8	4	8	7	3,4	5	8	good skin color, variable shape	some rot
2					5							
1	5	L-05-111	Cu	5	2	7	9	2,6	7	7	Some RC. More uniform shape than Bx, but skin not as smooth. YCR	RC, RKN
2			faded	6	3							
1	6	NC-07-364	Red	7	4	7	5	2,3,6	5	6	Good flesh color. Skin color similar as Diane, but more variable shape.	
2				8		6	6					
1	7	LSU52 G1	Orange	9	4	9	8	2,5	7	8	Some cracks. 1 rot. Smooth skin	wireworm cracks
2				10	4						Kind of chunky.	
1	8	NC-87-847	buff/tan	7	2.5	7	7	3,6	7	7	yellow/orange flesh, little lumpy	cuts
2				6		8	6				veins. Good skin color and shape	
1	9	L-09-149	burgundy	8	4	9	7	2,3	8	9	Great appearance, best shape and color. Storing well	
2				9								
1	10	Bonita	buff	8	1	8	7	2,3,6	6	7	Smooth skin, some veins. Good color	
2			tan	9	2		8					

Skin color:

cream (Hanna)
Tan
copper (Jewel)
Rose (Beau)
Purple (Garnet)

Skin Texture:

1 = very rough
3 = moderately rough
5 = moderately smooth
7 = smooth
9 = very smooth

Flesh Color:

0 = white
1 = cream
2 = yellow
3 = orange
4 = deep orange
5 = very deep orange

Eyes:

1 = very deep
3 = deep
5 = moderate
7 = shallow
9 = very shallow

Lenticels:

1 = very prominent
3 = prominent
5 = moderate
7 = few
9 = none

Shape:

1 = round
2 = round-elliptical
3 = elliptic
4 = long elliptic
5 = ovoid
6 = blocky
7 = irregular
8 = asymmetric

Shape Uniformity:

1 = very poor
3 = poor
5 = moderate
7 = good
9 = excellent

Overall Appearance:

1 = very poor
3 = poor
5 = moderate
7 = good
9 = excellent

All ratings made on #1 roots.
YCR = yellow cortical ring
RC = Russet Crack
RKN = root knot nematode
LG = longitudinal grooves
Culls = main reason for culls

NATIONAL SWEETPOTATO COLLABORATORS SUMMARY OF DATA 2014

STATE AND LOCATION REPORTING: Livingston, CA

DATE TRANSPLANTED: 5/16/2014. DATE HARVESTED: 10/9/2014. No. GROWING DAYS: 146

DISTANCE BETWEEN ROWS (in): 40. DISTANCE IN ROW (in): 10

PLOT SIZE: NO. OF ROWS: 2 LENGTH (ft): 50 NO. OF REPS: 4

IRRIGATION: drip irrigation. 1.5 to 2 inches per week during summer, total 30".

FERTILIZER: PPI 60 gpa 8-8-8 followed by drip applied 10-0-10. About 125-50-125 N-P2O5-K2O.

SELECTION	CLASS	40 lb box/A					BINS/A	% US #1'S	
		US #1'S	CANNERS	JUMBOS	MKT YIELD			CULLS	
1 Covington	yam	632.7	239.2	246.5	1118.4		41.2	56.7%	1.7%
8 NC 07-847	sweet	577.7	247.3	230.2	1055.2		38.8	54.9%	1.9%
9 L-09-149	red	570.5	287.6	224.5	1082.6		39.8	52.5%	0.8%
6 NC 07-364	red	552.2	197.8	258.8	1008.7		37.1	54.8%	0.5%
10 Bonita	sweet	530.5	193.8	330.6	1054.9		38.8	50.2%	2.2%
4 Diane	red	530.1	261.5	302.6	1094.2		40.3	48.6%	1.7%
2 Cal Bx G1	yam	512.0	196.8	344.1	1052.9		38.7	48.6%	6.1%
5 L-05-111	yam	501.6	241.5	405.8	1149.0		42.3	43.6%	3.9%
7 LSU52	yam	469.1	185.2	382.5	1036.9		38.2	45.2%	4.9%
3 Burgundy (175 G2)	red	442.8	154.5	334.8	932.1		34.3	47.7%	2.8%
Average		531.9	220.5	306.0	1058.5		39.0	50.3%	2.6%
LSD 0.05		92.9	53.8	115.4	ns		ns	6.0%	3.2%
CV, %		10.4	14.6	22.3	8.4		8.4	7.1	70.8

US #1's Roots 2 to 3.5 inches in diameter, length 3 to 9 inches, well shaped and free of defects.

Canners Roots 1 to 2 in diameter, 2 to 7 inches in length.

Jumbos Roots that exceed the size requirements of above grades, but are marketable quality.

Mkt Yield Total marketable yield is the sum of the above three categories.

bins/A bins/A are estimated based on market box yield assuming 23 boxes (18.4 Bu) per bin.

% US #1's Weight of US #1's divided by total marketable yield.

% Culls Roots greater than 1" in diameter that are so misshapen or unattractive as to be unmarketable.

LSD 0.05 Least significant difference. Means separated by less than this amount are not significantly different (ns).

CV, % Coefficient of variation, a measure of variability in the experiment.

SCORE SHEET FOR EVALUATION OF SWEETPOTATO SPROUT PRODUCTION - NSPCG TRIAL

Date bedded: 2/25/14

Location: Quail H Farms
Sunset and Howard Rds

Date Evaluated: 4/9/14

Type of bed: cold bed

Evaluated by: S. Stoddard

Botran & Devrinol at bedding

Selection	Roots presprouted yes/no	Plant Production 1-5 (1)	Uniformity of Emergence 1-5 (2)	Earliness 1-3 (3)	Root Conditions 1-5 (4)	Remarks (5)
1 Covington	yes	4	3	2		similar as production bed
2 Cal Bx G2	yes	4	4	3		good size and production
3 L-175 G2 (Burgundy)	yes	3	4	1		smaller but uniform
4 Diane	yes	5	5	3		largest plants and production
5 L-05-111	yes	3	3	2		more variable size than Bx
6 NC-07-364	yes	4	4	2		good production but slightly slower
7 LSU52	yes	1	1	1		almost nothing
8 NC -07-847	yes	4	2	2		variable size
9 L-09-149	yes	5	5	3		ALT bed
#						
#						
#						

- (1) Plant production rated from 1 – 5 based on observation during pulling season. A rating of 1 indicates low plant production, while 5 indicates good plant production.
- (2) Uniformity of emergence rated from 1 – 5. One (1) indicates poor uniformity while 5 indicates the highest degree of uniformity of emergence.
- (3) Earliness of plant production is rated from 1 – 3. One (1) indicated late emergence while 3 indicates early production.
- (4) Root conditions six weeks after first pulling, rated 1 – 5. One (1) indicates complete rotting, while 5 indicates perfectly sound conditions.
Mostly not applicable as beds were disced shortly after transplanting.
- (5) Notes on size of root, decay in beds, etc.

Sweetpotato ALT 2014

Scott Stoddard, Farm Advisor

The ALT in 2014 was conducted with Dave Souza with plants from NC State and LSU, east end of field on Rose Ave east of Hull Rd. Varieties from beds and shipped. Planted on June 3, 2014 25 plant plots, 12" spacing, 1-row, drip irrigation. Bonita field, vigorous early growth, late season irrigation cutoff Harvest on Oct 16 and 17, 2014. No yield weights taken, but production estimated from buckets. 1 tote in storage

Variety	Bucket Yield				Harvest notes	status 2015
	#1's	Mediun	Jumbo	Total		
L-09-149	0.5	1	0.5	2	Purple skin, orange flesh. Round, poor set = 2	KEEP
L-09-149	0.5	1	0.5	2	Small, poor set. Some cracks. Set = 2	
L-11-119	1.5	1.5	0.1	3.1	Red, good shape, but small. Good set = 4	
L-11-119	1.5	2	1	4.5	Red, small but good set = 4	KEEP
L-11-140	1	1	0.5	2.5	Purple. Veins, growth cracks, variable shape	
L-11-140	0.5	1	0.1	1.6	No roots, overgrown by next plot? Set = 1	
L-12-101	1	1	1.5	3.5	orange/orange. Air cracks. Set = 4	
L-12-15	1.5	0.5	2	4	Purple. Misshape and variable. Lenticles	
L-12-15	1	1	2	4	Purple, growth cracks. Set = 3	
L-12-158	0.5	1	0.5	2	Rose/orange. Wireworm damage, cracking. Set = 3	
L-12-36	1.5	1.25	0.5	3.25	Shape? Purple-red	
L-12-36	1	1	0.25	2.25	Purple skin, small. Set = 2	
L-12-52	1	2	0.25	3.25	Purple, good set = 4	DROP
L-12-52	1.5	1.5	1	4	Thick purple skin, nice shape. Set = 3	
L-12-97	1	2	0.5	3.5	small. Poor set. Red	
L-12-97	1	1.5	0.5	3	Red, good shape. Set = 3	
L-13-03	1	1.5	4.5	7	orange/orange. Variable shape and size. Set = 4	
L-13-05	1	1	2	4	Rose-red with white flesh. Smooth skin. Set = 3	
L-13-132	0.5	0.5	4	5	Purple with white flesh, good yield. Set = 3	KEEP
L-13-133	1	0.75	2	3.75	Purple/orange. Set = 3.	
L-13-135	0.75	0.5	2	3.25	Red/orange. Smooth skin, set = 2	
L-13-136	0.5	0.5	0.1	1.1	Light orange/light orange. Rough skin. Set = 1	DROP
L-13-148	0.5	1.5	1	3	Red with white flesh, Set = 2	DROP
L-13-160	1	1	1	3	red skin. Set = 3	
L-13-165	1	1	1	3	Purple/purple. Lumpy. Grooves. Set = 3	
L-13-166	1	1	1	3	Red, slender, grooves. Set = 2	
L-13-172	0.5	1	0.1	1.6	Maroon skin, small. Set = 4	
L-13-174	1	1	2	4	Lt red with white flesh, rough skin. Set = 3	
L-13-176	1	1.5	1.5	4	Red with nice set and shape. Set = 4	KEEP
L-13-180	0.5	0.5	0.5	1.5	Pink red skin, low yield. Set = 1	DROP
L-13-181	1	1.5	0.5	3	Red/orange. Good shape. Set = 3	KEEP
L-13-182	1	1	1.5	3.5	Purple skin, lt orange flesh. Set = 3	
L-13-183	0.5	1	1	2.5	Orange skin, low yield. Set = 3	
L-13-190	0.5	0.5	0.25	1.25	Purple/orange. Set = 2	

Variety	Bucket Yield				Harvest notes	status 2015
	#1's	Mediun	Jumbo	Total		
L-13-192	1	0.75	1.1	2.85	Lt red. Root sprouts. Set = 3	
L-13-216	1	1	1	3	Already sprouting, ridges. Set = 3	
L-13-218	1	1	2	4	Red skin. Lumpy. Veins. Set = 2	
L-13-34	1.1	1.5	0.5	3.1	Purple skin with cream flesh. Skin linear. Set = 4	
L-13-37	0.5	1.5	1	3	tan with orange flesh, low yld. Set = 2	DROP
L-13-38	0.5	1	3	4.5	Purple skin, white flesh. Lumpy, rough. Set = 2	
L-13-58	1.5	1	2.5	5	Tan skin, veins. Set = 2	
L-13-60	1.25	1.5	2	4.75	Looks like Bonita. Cream flesh. Set = 4.	KEEP
L-13-63	0.75	1	4	5.75	Lumpy, too round, variable shape. Set = 3	
L-13-64	1	0.5	1	2.5	Red skin, white flesh. Set = 2	
L-13-86	1	1	0.5	2.5	white skin, white flesh. Set = 2	
NC08-036	1	1	1.5	3.5	Red rose. Lents prominent, rough skin	
NC08-036	1	1	2	4	Red skin. Lenticles, pimples, rough. Set = 3	
NC08-553	1	0.5	0	1.5	Tan skin. Low yield, rough, long. Set = 2	KEEP
NC08-553	1.5	2.5	0.5	4.5	Sweet. Tan/white, good shape. Small. Set = 4	
NC09-350	0.5	0.5	1	2	Red, low yield	
NC09-350	0.5	2.5	0.5	3.5	Red, lumpy, on/off set. Set = 2	
NC09-609	0.5	1	0	1.5	Small, red/orange. Veins. Set = 3	
NC09-609	1	1	0.5	2.5	Red, smooth, good set = 4	
NC09-707	1	1	2	4	Red/cream flesh. Lumpy. Set 3	
NC09-707	1	1	2	4	Red skin, white flesh. Veins, eyes. Set = 3	
NC10-104	1.5	1	3	5.5	Red, growth cracks. Long, but yields. Set = 4	KEEP
NC10-104	1.5	2	5	8.5	Big yields, mostly smooth. Set = 4	
NC10-421	1	1	1	3	Red. Growth cracks, set = 3	
NC10-421	1.5	1	0.5	3	Red purple skin, good shape, growth cracks. Set = 4	
NC11-805	1	1	1	3	Sweet. Veins, sprouts, latex	KEEP
NC11-805	1	0.5	1	2.5	reddish tan skin, rough, lenticles. Set = 2	
NC11-825	0.5	1	0.25	1.75	Purple/white. Smooth, small	DROP
NC11-825	0.5	1	0	1.5	Red, white flesh. Set = 2	
NC11-863	0.5	0.5	0.5	1.5	purple skin orange flesh. Good shape. Set = 2	
NC11-863	0.5	0.5	1.5	2.5	Purple skin, smooth. Set = 3	
NC11-980	2	1.5	2.5	6	Purple skin, looks nice, but air cracks. Set = 4	KEEP
NC11-980	1.25	1.5	1	3.75	Purple, good shape, color, set = 4	

SCORE SHEET FOR EVALUATION OF SWEETPOTATO SPROUT PRODUCTION - ALT 2014

Date bedded: 2/28/13

Location: D&S Farms

Atwater, CA

Date Evaluated: 4/16/13

Type of bed: cold bed, sprinkler irrigated

Evaluated by: S. Stoddard

Selection	Roots presprouted yes/no	Plant Production 1-5 (1)	Uniformity of Emergence 1-5 (2)	Earliness 1-3 (3)	Root Conditions 1-5 (4)	Remarks (5)
1 L-11-140	yes	3	3	2		dull purple new growth
2 L-12-07	yes	4	4	1		good production sm plants
3 L-12-15	yes	3	2	2		round leaves mostly green
4 L-12-36	yes	1	3	1		small and sparse
5 L-11-119	yes	5	4	3		purple new growth good size
6 L-09-149	yes	5	5	3		best plant production
7 L-12-52	yes	3	2	2		purple new growth lg round lvs
8 NC-10-421	yes	4	3	3		all green some plants very lg lvs
9 NC-09-707	yes	2	2	2		lg purple new growth
10 NC-08-036	yes	4	4	3		all green deep crinkle
11 NC-10-104	yes	4	4	2		all green good production but
12 NC-08-553	yes	3	3	2		low production

- (1) Plant production rated from 1 – 5 based on observation during pulling season. A rating of 1 indicates low plant production, while 5 indicates good plant production.
- (2) Uniformity of emergence rated from 1 - 5. One (1) indicates poor uniformity while 5 indicates the highest degree of uniformity of emergence.
- (3) Earliness of plant production is rated form 1 – 3. One (1) indicated late emergence while 3 indicates early production.
- (4) Root conditions six weeks after first pulling, rated 1 – 5. One (1) indicates complete rotting, while 5 indicates perfectly sound conditions.
Mostly not applicable as beds were disced shortly after transplanting.
- (5) Notes on size of root, decay in beds, etc.

Red Yam Trial 2014

Scott Stoddard, Farm Advisor
UCCE Merced County

The objective of the red yam trial is to evaluate red skin lines, especially L-04-175 (now named “Burgundy”), in replicated plots. Plot size was 2 rows x 50 feet, and replicated 4 times in a commercial field. In 2014, this was done with Dave Souza near Sultana and Olive Rds. Also included this year was a comparison of slips and vine cuttings of Burgundy. The plots were transplanted May 16 on 12” plant spacing and harvested September 29.

Results:

The varieties in the trial in 2014 are listed in Table 1. Significant differences were observed for all size categories, with 175 plants cut from the bed having the least #1 and total yield. #1’s were 40% compared to 54% for Diane. L-04-175 from vine cuttings had the highest total marketable yield in the trial, estimated at > 57 bins per acre, but only 45% #1’s (Table 2). Root quality was excellent for all cultivars, with very few culls in any of the varieties except L-11-140.

L-04-175 has been tested extensively in Merced County, in both replicated plots and strip trials. A summary of results from 2007 – 2014 is shown in Table 3. This variety usually had significantly greater total yield than Diane, especially when virus-tested plants were used after 2009. Overall, G0 plants had highest No. 1’s and total yield and lowest cull% (Table 3), but G1 and old 175 seed were very similar. While not shown in Table 3, color and shape were better with G1 seed as compared to old seed. Across all locations #1’s averaged ~47%, but at one location was only 22%. 175 grows fast and jumbos easily. This variety should probably be grown on 9 – 10” plant spacing with expected harvest of 90 – 110 days.

L-04-175 has twice the sucrose and ½ the maltose of Beauregard, which gives it very good flavor. In the bake and microwave sensory evaluation trial conducted at Mississippi State, 175 was the only entry of 9 (including Covington, Beauregard, L-06-52, Orleans, O’Henry, & Bonita) that had acceptable scores on sweetness and flavor in the microwave tests. In the baked test, it was ranked second. In the insect screening trial done at the USDA ARS Charleston South Carolina Station, 175 ranked second behind the highly resistant check cultivar “Ruddy” in the level of uninjured roots from the WDS (wireworm, Diabrotica, and Systena) complex, at 69% uninjured roots.

Despite these positive characteristics, it is unlikely that 175 will achieve commercial success in California or the U.S. Yields are too variable, especially when compared to the resilient cultivar Diane. Furthermore, its tendency to jumbo and become bally is a major limitation. In commercial fields, set has been poor, usually less than 4 roots per plant. The reason for the rapid loss of yield suggests the clone at UCDavis has mutated.

L-04-175 has been officially released by LSU and named “Burgundy” in reference to its skin color. This cultivar is patented and requires a license to grow.

Table 2. Yield results of varieties in the "red yam" trial, Merced County 2014.

variety	40 lb box/A			TMY box/A	Market bins/A	No. 1's #1%	Culls cull%
	No. 1's	Meds	Jumbos				
1 Diane	688.0	283.9	297.0	1269.0	46.7	54.2%	1.7%
2 Burgundy G0 vine-cl	716.6	167.3	680.2	1564.2	57.6	45.8%	0.6%
3 L-09-149	676.9	291.3	325.3	1293.5	47.6	52.3%	1.8%
4 NC-10-104	471.7	147.9	828.1	1447.8	53.3	32.6%	2.1%
5 L-12-52	560.9	266.5	463.8	1291.2	47.5	43.4%	1.6%
6 L-11-140	628.6	194.2	392.3	1215.1	44.7	51.7%	17.2%
7 Burgandy G1 bed	497.9	137.3	604.6	1239.8	45.6	40.2%	0.9%
Red average	622.8	231.4	518.9	1373.1	50.5	45.7%	3.7%
LSD 0.05	97.5	47.5	120.0	150.0	6.0	5.7%	5.0%
CV, %	10.7	15.3	15.6	7.6	7.6	8.4	91.0

TMY Total marketable yield is the sum of #1's, jumbos, and mediums.
bins/A bins/A are estimated assuming 1000 lb bin.
% US #1's Weight of US #1's divided by total marketable yield.
Culls Roots greater than 1" in diameter that are so misshapen or unattractive as to be unmarketable.
LSD 0.05 Least significant difference. Means separated by less than this amount are not significantly different (ns).
CV, % Coefficient of variation, a measure of variability in the experiment.

Table 3. Yield summary for L-04-175 red yam, Merced County all locations 2007 - 2013.

Selection		40 lb box/A			TMY box/A	Market bins/A	No. 1's #1%	Culls cull%	site n
		No. 1's	Meds	Jumbos					
L-04-175 old		395.6	124.5	382.2	902.3	31.8	44.4%	11.6%	11
L-04 -175 G1		412.4	157.8	489.9	1060.1	38.2	44.0%	3.9%	16
L-04-175 G0		674.5	283.4	578.0	1536.0	54.4	47.6%	1.1%	25
Diane (mix G)	Standard	544.3	307.8	268.1	1120.1	40.0	48.4%	14.7%	13

LSU52 cracking evaluation

fall 2014

Method:

200 ft of one bed was harvested and samples of #1, Jumbo, and Mediums were taken randomly along the length of the bed. Ended up with about 6 buckets of each size category.

Roots were then evaluated for air cracks (yes/no, no severity score)

Location: Weimer Field, SW corner of Arena and Bell.
East of house in middle of field

Late field, harvest began mid Oct.

Results: No clear association between soil or air temp and cracking. Jumbos had greater occurrence of developing cracks as compared to smaller roots.

Table 4. Summary, Bellevue cracking evaluation at late season harvest (2014).

HARVEST DATE		TIME	TEMPERATURE (F)		% AIR CRACKING		
			AIR	SOIL 4"	#1's	Jumbos	Mediums
16-Oct	11:00		64	68	18.6%	31.9%	11.5%
17-Oct	15:00		81	69	5.3%	13.8%	10.1%
22-Oct	14:30		75	67	14.4%	18.1%	9.6%
5-Nov	14:30		69	64	7.6%	16.2%	4.4%

Based on randomly selected roots from 200 ft of bed during mechanical harvest.



Movento on Sweetpotatoes 2014

Scott Stoddard, Farm Advisor

Objective: Evaluate Movento (spirotetromat), Serenade Soil (*Bacillus subtilis*), and AR83685 on nematode control and impacts on sweetpotatoes

Location: buffer zone in a commercial field off Sultana Rd in Merced County

Cooperator: Nolan Mininger

Variety: Burgundy, transplanted April 30, 2015. Drip irrigated

Start/Stop: Treatments began May 29, field harvested July 16

Treatments:

#	Treatment rate	Application Date			
1	UTC	-	-	-	-
2	AR83685 8.55 fl oz/A early	3-Jun	-	-	-
3	AR83685 8.55 fl oz lay-by	-	-	17-Jun	-
4	AR83685 8.55 fl oz lay-by +	-	-	17-Jun	25-Jun
5	Serenade Soil 1 gal	3-Jun	-	-	25-Jun
6	Serenade Soil 2 qts	3-Jun	10-Jun	17-Jun	25-Jun
7	Movento 5 fl oz foliar	17-Jun	-	-	30-Jun

Treatments 2 - 6 injected into irrigation tape while irrigating using ½ gallon per plot
Plot size: 2 rows x 50', 4 reps. Surface drip tape down the center of the rows

Notes: nematode samples taken May 29 from untreated plot area (composite) and adjacent area which was fumigated with Telone (1,3-D) at 12 gpa.
2nd nematode samples taken on Jul 11, composite from all reps. Analysis by Denele Analytical Labs in Turlock.

Burgundy is a nematode resistant variety.

Harvested early because of lack of water, strong market for reds

AR83685 treatments are crop destruct

Summary: All treatments except Movento were injected thru a secondary drip tape during the growing season for each plot by calculating the per plot rate, then mixing with 1/2 gallon water, injecting, then followed by irrigation water for 10 - 15 minutes (Figure 1). While located in a non fumigated portion of a field with a previous history of high nematode counts (note July counts averaged >850 RKN per 500 cc soil), grower used a highly resistant variety (Burgundy) and harvested very early. As a result, there was little time for the treatments or the nematodes to have impact. Both rows of the 50 ft plots were harvested using a commercial 1-row harvester and sorted by the grower's labor crew into minis, mediums, and number ones. Minis are very small roots (<50 g) not normally harvested. Due to the early harvest, there were no jumbo roots. No visual differences between plots, and no significant differences were noted for yield between any of the treatments (Table 1). There were almost no cull roots, however, where there were some culls they were in the nematode plots and were caused by RKN cracking. July nematode counts were high but were not replicated, so no statistical analysis could be made.



Figure 1. AR83685 and Serenade Soil were injected into a secondary line attached to the main irrigation tape, then flushed with water for 10 – 15 minutes to move them into the soil.

Table 1. Movento and AR83865 insecticide trial on sweetpotatoes, 2014.

#	Treatment and rate (1)	BINS PER ACRE (1000 lbs)				RKN on 7/11	
		Mini	Mediums	No.1's	TMY (2)	% No. 1's	#/500 cc (3)
1	UTC	2.0	2.5	7.1	11.5	61.1%	720
2	AR83685 8.55 fl oz/A early	2.3	2.6	8.3	13.2	62.9%	898
3	AR83685 8.55 fl oz lay-by	2.7	2.7	7.8	13.2	58.8%	1002
4	AR83685 8.55 fl oz lay-by +	2.2	2.8	7.1	12.2	58.1%	762
5	Serenade Soil 1 gal x 2 apps	2.5	2.6	6.6	11.7	55.9%	1134
6	Serenade Soil 2 qts x 4 apps	2.2	1.9	6.2	10.3	60.4%	956
7	Movento 5 fl oz 2 apps	2.4	2.2	7.9	12.5	63.1%	716
	Average	2.3	2.5	7.3	12.1	60.1%	884
	LSD 0.05	ns	ns	ns	ns	ns	---
	CV%	19.9	25.9	23.0	19.4	8.3%	---

1) All treatments injected into drip line during irrigation.

2) TMY = Total Marketable Yield, the sum of all the size groups. Minis are very small roots (<50 g).

3) RKN = Root Knot Nematode. Composite sample at harvest.

LSD Least significant difference at the 95% confidence level.

CV coefficient of variation.

Sweetpotato fungicide trial 2014

Scott Stoddard, Farm Advisor

Location:	field near Ballico. Corner of Harding and Cortez, east side of field hotbeds off Lincoln	
Cooperator:	Blaine Yagi, Yagi Bros Farms	
Variety:	Japanese (Kenney 12 or equivalent)	
Treatments:	<u>Bed spray (Feb 25)</u>	<u>Plant dip (April 23)</u>
	1. UTC (water 2 gallons)	1b. Water
	2. Serenade Soil 6.4 fl oz in 2 gals	2b. Serenade Soil
	3. Botran 5F 6 fl oz in 2 gals	3b. Botran
	4. Mertect 340 2.5 fl oz in 2 gals	4b. Mertect
	5. Double Nickel 7.2 fl oz in 2 gals	5b. Maxim 4FS 15 ml/gal
	6. Topsin 8 oz in 2 gals	6b. Topsin
	all in 2 gallons water	
	plot size: 8' x 10', rep 4x	plot size: 10 plants, one row
	total 240 sq ft per treatment	

Other treatments:

101, 201, 301, 401 pulled plants

101 pulled dipped in Topsin and 201 pulled dipped in Topsin

field layout: RB split plot with 4 reps.

plot size: 1 bed by 10 plants (about 10 ft)

At transplanting on April 23:

Plants cut 4/21, split into dip and no-dip treatments

small number also just pulled

Harvest: 9/9/15 used 2-row digger, then sorted into buckets

SUMMARY

This was a fungicide trial to evaluate the efficacy of various fungicides applied at bedding and again before transplanting to sweetpotatoes to control stem rot, *Fusarium oxysporum f.sp. batatas*. The variety used was a *Fusarium* susceptible Japanese variety similar to Kotobuki in appearance (purple skin and white flesh). The first application occurred on 25-Feb-2014 to exposed roots in the hotbeds immediately before they were covered with soil. A second application was made to slips (cut plants) as a plant dip on April 23 just before transplanting (Figure 1). Fungicide rates were based on label recommendations then adjusted to equivalent quantities for 2 gallons of water. Fungicides included Serenade Soil biofungicide (*Bacillus subtilis*), Botran (Dicloran), Mertect (thiabendazole), Double Nickel (*Bacillus amyloliquefaciens*), Topsin (thiophanate-methyl), and Maxim (fluidoxonil). Because Maxim (fluidoxonil) could not be acquired before bedding, it was only used as a plant dip after Double Nickel at the suggested rate for root treatment of 0.08 fl oz per 100 lbs, which in this test was 2 gallons to cover about 1600 lbs of roots, or 1.28 fl oz/2 gallons = 19 ml per gallon. Plants were dipped for 2 minutes, and then allowed to drain before transplanting. All plants were cut about 1 inch above the soil line except for one treatment that used pulled plants. Transplanting was done with a standard 6-row finger planter with 10 plants per plot. Approximately 6 weeks after transplanting the plots were evaluated for overall plant

health and yellow plants and missing plants were recorded at this time. Harvest was done with a 2-row digger and separated into standard size grades. Culls were separated into roots with obvious stem rot when possible. Because of the small size of these plots and the resulting high variability, yields have not been adjusted to bin per acre equivalents.

Results are shown in Tables 1 and 2 and in Figure 2. Stem rot was very high in these plots, ranging from 5 to 35% at the July 7 evaluation date, and 1.5 – 19% in the harvested roots. The Maxim plant dip treatment resulted in the least amount of yellow (sick) plants and best overall yields, while Mertect was just the opposite. The high number of missing plants in the Mertect treatment suggests the dipping time was too long which increased planting mortality. None of the other treatments had a significant effect on stem rot or yield as compared to the untreated control. Ironically, the pulled plants fared very well in this test and showed no more stem rot then the plants that were cut, even though cutting is a recommended practice to control this disease. Future plans should evaluate the combination of Maxim with pulled plants.

Acknowledgements. Many thanks to Blaine Yagi for his cooperation with this test, as well as Syngenta (Derrick Hammons) and Bayer Crop Science (Seth Gersdorf) for product support.



Figure 1. Fungicides were applied to the beds and at transplanting as a plant dip.

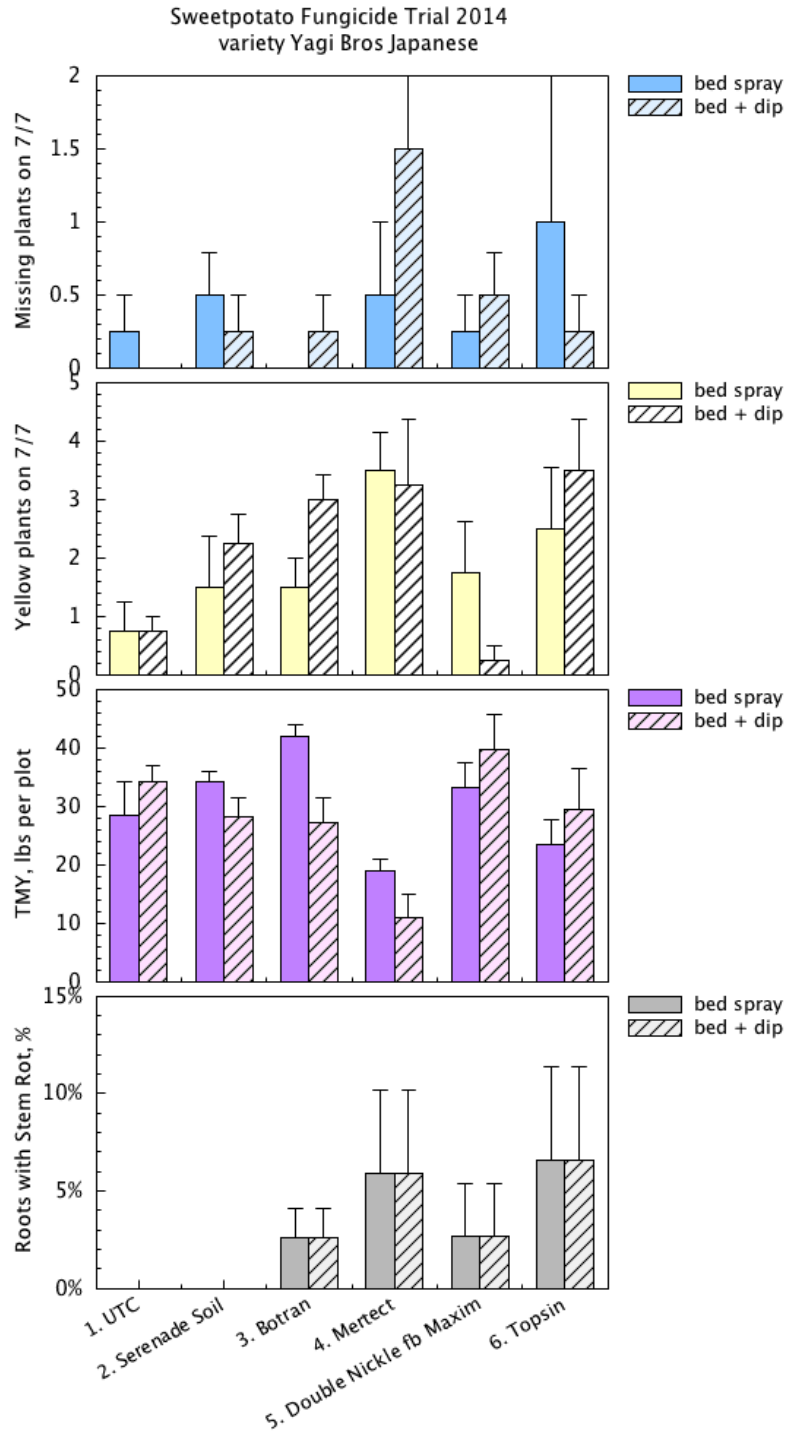


Figure 2. Treatment averages for missing plants, yellow plants, total marketable yield (TMY), and infected roots for the main and split plot treatments.

Table 1. Stem rot fungicide efficacy trial in sweetpotatoes (variety Kenne 12), Yagi Bros Farms 2014.

Treatment (1)		July 7 plant count (2)		Harvest yield, lbs per plot (3)				Culls (4)	
hotbed spray, oz/2 gallons	plant dip	missing	chlorotic	No.1's	Medium	Jumbo	TMY	Stem Rot %	Cuts %
1 UTC (water, 2 gallons)	Water	0.12	0.75	20.6	4.8	5.9	31.3	1.5	15.5
2 Serenade Soil 6.4 fl oz	Serenade Soil	0.38	1.88	14.9	3.7	12.5	31.0	4.8	15.0
3 Botran 5F 6 fl oz	Botran	0.13	2.25	18.1	4.3	12.1	34.5	6.4	11.3
4 Mertect 340 2.5 fl oz	Mertect	1.00	3.38	8.5	2.3	4.1	14.9	18.9	7.4
5 Double Nickle 7.2 fl oz	Maxim 4FS 15 ml/gal	0.38	1.00	20.2	4.6	11.5	36.3	1.4	14.1
6 Topsin 8 oz	Topsin	0.63	3.00	14.1	3.5	8.7	26.3	6.8	4.8
7 UTC with pulled plants	water **	0.83	0.17	22.6	3.4	11.2	37.1	1.7%	17.8%
average		0.44	2.04	16.1	3.9	9.1	29.1	6.6	1.3
hotbed spray LSD 0.05		ns	1.75	5.1	ns	ns	9.2	ns	ns
plant dip LSD 0.05		ns	ns	ns	ns	ns	ns	ns	ns
CV, %		151	54	29.4	54	63	21	221	104

1) fl oz of product per 2 gallons per 240 sq ft of hotbed. Plant dip used same rates, bundled plants cut and dipped for 2 minutes.

2) Plot evaluation counting missing or yellow plants out of 10 transplanted.

3) Plot size 1 row by 10 plants. Due to the small size, yield per acre not estimated.

4) Culled roots at harvest as a percentage of total marketable yield (TMY)

** Pulled plants shown for comparison but not included in statistical analyses (all others cuttings).

LSD = Least Significant Difference, ns = not significant.

Table 2. Soil sample test results from various sweetpotato fields in 2014 (DANR labs, UC Davis). The fungicide trial is highlighted in bold at the bottom.

SAMPLE #	SP %	pH	EC dS/m	Ca (SP) meq/L	Mg (SP) meq/L	Na (SP) meq/L	Cl (SP) meq/L	B (SP) mg/L	NO3-N ppm	Olsen-P ppm	X-K ppm	Zn (DTPA) ppm	Mn (DTPA) ppm	Cu (DTPA) ppm	Fe (DTPA) ppm
3 Fumigation NM	26	8.03	0.50	1.54	0.73	3.01	0.64	0.10	7.75	3.7	30	0.7	10.7	0.2	18.9
4 Fumigation RG	25	7.06	1.82	9.61	5.35	3.60	1.71	0.22	22.70	80.7	142	7.5	11.3	6.4	33.0
5 P trial 0-12"	23	6.21	0.62	4.54	1.01	0.56	0.93	0.06	6.50	44.1	39	2.9	13.5	4.8	62.9
6 P-Trial 12-24"	23	6.17	0.84	6.51	1.22	0.56	1.97	0.05	7.80	48.3	27	0.8	11.7	1.7	53.3
7 NSPCG	29	8.10	1.44	2.75	0.61	10.72	6.79	0.21	5.25	19.3	36	1.9	11.6	0.6	25.8
8 Red Yam	24	7.15	1.20	10.93	1.70	0.63	0.25	0.08	11.90	10.3	32	2.2	14.7	7.2	60.9
9 SP fungicide	26	7.29	0.70	2.77	0.97	2.51	0.95	0.09	2.50	12.5	72	3.8	11.4	5.2	37.7

Dominus Fumigation Trial 2014
Scott Stoddard, Farm Advisor

OBJECTIVE: Evaluate the new AITC biofumigant "Dominus" for efficacy in commercial sweetpotato fields alone and in combination with Telone and Pic Plus.

COOPERATORS: Nathan Mininger (NM), grower
Robert Garcia (RG), grower
Paul Domecq, Tri Cal
Lonnie Slayton, Simplot
Adam Cholakian, Isagro

LOCATION: #1). Nathan Mininger: Machado Ranch, SW corner Washington and Hwy140, south of Livingston, CA. Soil: Hilmar sand, slightly saline-alkali, Storie Index 32.
#2). Robert Garcia: North of Hwy 99 and Bradford overpass, near Turlock. Soil: Hilmar loamy sand, Storie Index 66. See Table 1 for soil analysis results.

TREATMENTS:		Application date	
		<u>SITE 1</u>	<u>SITE 2</u>
1	UTC	NA	NA
2	Dominus 10 gpa	22-Apr	23 Apr
3	Dominus 5 gpa + Telone 5 gpa	22-Apr	23-Apr
4	Dominus 5 gpa + Pic Plus 5 gpa	22-Apr	23-Apr
5	Pic Plus 10 gpa	22-Apr	23-Apr
6	Gwr Standard 12 gpa Telone	2-Apr	9-Apr
7	PicPlus 15 gpa (RG only)	---	23-Apr

Treatment #6 applied site #1 on 2-Apr-2014
rain previous day good soil moisture
18" deep on 18" centers, followed by cultipacker to seal
Remaining treatments applied by Tri Cal on April 22, 2015 using noble plow set up to Site #1

Site #2: all treatments but Telone applied by Tri Cal on April 23

plots 26' feet wide x 300' long except where noted on plot plan, 4 reps. Some plots were 40 feet wide (fumigation swath). 4 to 6 transplanted beds per fumigation plot, with data taken from center bed.

NEMATODE: Both sites were nematode sampled after fumigation treatments and in the fall before harvest (June and 17-Sep or 8-Oct). Samples taken 0-12" from center of bed near drip tape and taken to Denele Labs in Turlock for species ID and population.

PLANT/HARVEST: Site #1 (NM): June 10. Burgundy, D&S White, and Covington were all planted through the plot area, resulting in yield estimates based on 2- 4 reps. Harvest October 30 – 31, 2014, 2 rows per plot entire plot length.

Site #2 (RG): May 22, cv 'Covington'. Harvest November 3-4, 2014.

SUMMARY

Sweetpotatoes are normally fumigated in California when possible, as it is the main method of pest management for growers. Key pests include root knot nematode, *Meloidogyne spp*, wireworms (larvae of the click beetle), and various grubs in the Scarab family. One of two fumigation treatments are commonly used: a preplant application of Telone (1,3-D) at 9 – 12 gallons per acre broadcast prior to bedding at 18” deep on 18” centers, or metam potassium/metam sodium at 45 – 65 gallons per acre broadcast prior to bedding at 9” deep on 9” centers. Telone is the preferred fumigant because of excellent control of nematodes at a reasonable cost (\$300 - \$400 per acre applied). However, Telone is subject to numerous state mandated restrictions, including the time of application (not in December or January because the application factor is 1.8x), 100 ft buffer zones, and most importantly, application caps of 92,000 lbs per township. In response to the application caps, growers have reduced rates or switched to using metam products, which are more expensive but have no use caps. Combinations of Telone and metam have been tested with good results, however, the combination treatments are prohibitively expensive.

In 2014, two fumigation trials were conducted in Merced (NM location) and Stanislaus (RG location) Counties in commercial sweetpotato fields to evaluate the efficacy of Dominus biofumigant as compared to standard Telone treatments on yield and root quality. Due to cost, the tested rate of Dominus was 10 gallons per acre. Other treatments included Dominus plus Telone at 5 gpa each, and Dominus plus Pic Plus. Tables 2 and 3 list the treatments used at each location. Treatment design was a randomized block with 4 replications. Fumigants were applied using commercial scale equipment by Tri Cal, Inc., (all Dominus treatments) or Simplot (for the standard Telone treatment) following good fumigation practices as outlined by county permit conditions. Telone was injected at 18” on 18” centers at 12 gpa and immediately followed by a shallow disc + ring roller to seal the shank paths. Tri Cal injected the Dominus using a noble plow set up (shanks with a broadcast “wing” at the base) at ~10” depth on 10” centers (Figure 1). Rates were adjusted using a Raven control unit, and the plots were sealed in a similar manner as Telone. All plots were at least 150 feet long by 22 feet wide (one round on a 11ft tool bar). The trials were transplanted 4 – 6 weeks after fumigation treatments with cultivar ‘Covington’ at the RG location near Turlock, and ‘Covington’, ‘Burgundy’, and ‘D&S White’ at the NM location. Covington and Burgundy are both nematode resistant cultivars. Nematode samples were taken at both locations in early June to determine efficacy of fumigation treatments and again at the end of the season, though only the fall nematode samples were replicated. Both field locations were drip irrigated. Harvest was done using the growers’ equipment and crew to separate into standard #1, Jumbo, and Medium size categories. The center bed of each plot for the entire length was weighed. Because the NM location had 3 varieties unevenly distributed across the plot area, only 2 – 4 replications per variety could be used for the analysis of harvest results.



Nematode and yield results are shown in Tables 2 and 3. No root knot nematodes were found in the June composite samples at either location. At the RG location, average yields were excellent, over 50 bins per acre total yield. All of the fumigation treatments with the exception of Telone resulted in a significant increase in No. 1's and total marketable yield (TMY) as compared to the untreated control. The Telone treatment appeared to have been applied improperly (either not at all or at a very reduced rate), as the initial strip for reps 1 and 2 grew slowly and yielded

poorly as compared to the rest of the field that received Telone. The Dominus 10 gpa treatments average 63 bins per acre, 9 more than the untreated check plot. Fall nematode counts were variable and not significant different between the treatments, and were likely not a factor in the results seen in this trial. Other than some scurf in certain areas, this field was very clean, with no significant differences in the amount of culls. Average cull losses were 5.6%.

The MN location had very high root knot nematode counts and nematode pressure was a significant factor in the yield and quality observed in the individual plots. Only the Telone treatment showed a significant reduction of nematodes in the fall, and even then counts were 864 per 500 cc – well above any reasonable thresholds. Culls were significantly greater in the UTC and Dominus + PicPlus treatments (Table 3), and almost all culled roots were due to nematode damage (Figure 2). Yield for these two treatments were also significant less than the other treatments, however, as with the RG location, there appeared to be an application error in the Dominus + PicPlus treatment (treatment #4) and it was probably applied at a reduced rate, as yields of D&S White and Covington were similar as the untreated control. Averaged over variety, Telone had the best No.1 and total marketable yield at 28.4 and 37.0 bins/A respectively, but these were not significantly different than the Dominus 10 gpa treatment. Results by variety are shown in Figure 3. D&S white probably has little nematode resistance, as the yields were very low in treatment 4, which also had very high fall nematode counts.

The results from these trials suggest that both Pic Plus at 10 to 15 gpa and Dominus at 10 gpa are viable alternatives to Telone and metam standards currently used by the industry. Additional work is planned in 2015.



Figure 1. Tri Cal noble plow setup to inject Pic Plus and Dominus fumigants in 2014.



Figure 2. Cull of D&S White variety were mostly caused from nematode damage (severe cracking) at the NM location. Fall soil samples had very high levels of RKN in the plots where this variety was grown. Burgundy is highly nematode resistant and did not show this degree of damage.

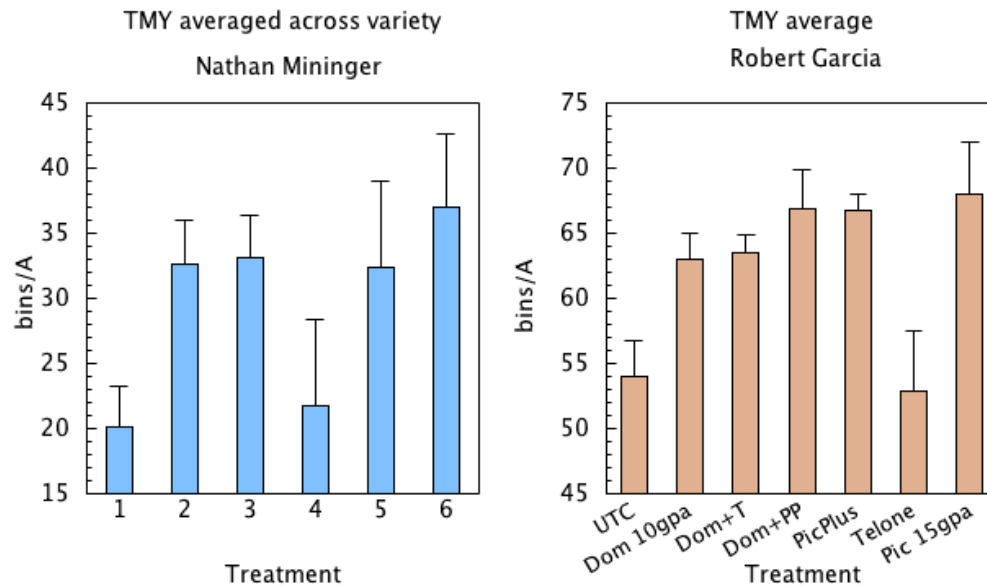
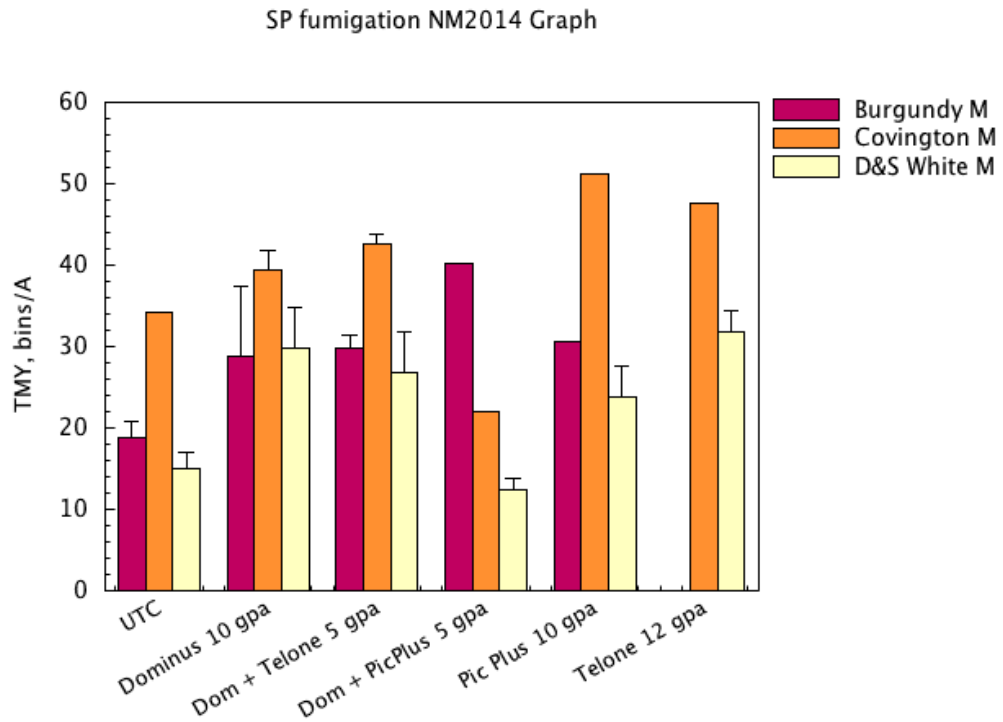


Figure 3. Total marketable yield (TMY), bins/acre by treatment, for each trial location in 2014.

Table 1. Sweetpotato Dominus fumigation trials, preplant soil samples (UC ANR analytical lab).

SAMPLE #	DESC	SP (200.02) %	pH (205.02)	EC (215.03) dS/m	Ca (SP) (235.04) meq/L	Mg (SP) (235.04) meq/L	Na (SP) (235.04) meq/L	Cl (SP) (227.02) meq/L	B (SP) (235.04) mg/L	NO3-N (312.03) ppm	Olsen-P (340.03) ppm	X-K (360.04) ppm	Zn (DTPA) (380.02) ppm	Mn (DTPA) (380.02) ppm	Cu (DTPA) (380.02) ppm	Fe (DTPA) (380.02) ppm
3	Fumigation NM	26	8.03	0.50	1.54	0.73	3.01	0.64	0.10	7.75	3.7	30	0.7	10.7	0.2	18.9
4	Fumigation RG	25	7.06	1.82	9.61	5.35	3.60	1.71	0.22	22.70	80.7	142	7.5	11.3	6.4	33.0

Table 2. Dominus fumigation trial on sweetpotatoes, fall nematode and yield results, RG (site #2) location, 2014.

treatment	July 7 growth		17-Sep Nematodes			sq root corrected			yield, bins/A (2)				US #1'S %	CULLS %
	inches (1)	Bed, %	# per 500 cc soil	Ring	Stubby	RKN	Ring	Stubby	RKN	#1's	Med	Jumbo	TMY	
1 UTC	12.6	79%	3846.0	324.0	0.0	55.6	15.0	1.0	34.3	10.7	9.0	54.0	63.2%	5.5%
2 Dominus 10 gpa	9.7	84%	1332.0	876.0	96.0	36.3	24.3	6.3	40.4	13.3	9.4	63.0	64.2%	4.0%
3 Dominus 5 gpa + Telone 5 gpa	7.3	88%	444.0	906.0	186.0	19.8	29.8	8.5	42.5	12.8	8.1	63.4	66.9%	5.2%
4 Dominus 5 gpa + PicPlus 5 gpa	6.9	89%	2112.0	576.0	942.0	40.8	19.8	23.7	41.5	13.2	12.2	66.9	62.1%	3.5%
5 PicPlus 10 gpa	6.5	89%	660.0	474.0	0.0	22.0	21.2	1.0	45.1	12.4	9.2	66.7	67.5%	6.0%
6 Telone 12 gpa	9.5	84%	72.0	276.0	72.0	5.6	16.4	5.6	36.5	11.5	8.7	56.7	64.4%	9.7%
7 PicPlus 15 gpa	4.8	92%	174.0	546.0	0.0	11.0	22.3	1.0	45.7	12.5	9.7	67.9	67.2%	5.1%
Average	8.2	86%	1234.3	568.3	185.1	27.3	21.2	6.7	40.8	12.3	9.5	62.7	65.1%	5.6%
LSD 0.05	3.6	---	---	---	---	28.0	ns	ns	7.6	ns	ns	9.0	ns	ns
CV, %	29.8	---	---	---	---	57.8	44.2	173.8	12.6	16.9	32.8	9.7	5.8	75.0

1) Average width of space between two rows on one bed, used to estimate bed coverage and early season plant growth.

2) Yield estimated from 2 row plot, 1000 lbs per bin. TMY = total marketable yield.

3) LSD 0.05 = Least Significant Difference at the 95% confidence interval. NS = not significant. --- = no replicated data

4) CV = coefficient of variation.

Table 3. Dominus fumigation trial, fall nematode sampling results and main effects on yield, NM (Site #1) location 2014.

Treatment	8-Oct Nematode results (1)			Nematodes			yield, bins/A (2)				US #1'S %	CULLS %
	Ring	Stubby	RKN	Ring	Stubby	RKN	#1's	Med	Jumbo	TMY		
1 UTC	0	189	4068	0	10.0	63.3	13.7	5.4	0.9	20.0	66.7	12.9
2 Dominus 10 gpa	0	405	2061	0	16.8	43.6	24.7	6.5	1.4	32.6	75.0	3.0
3 Dominus 5 gpa + Telone 5 gpa	0	509	2120	0	22.5	45.3	24.8	6.2	2.0	33.0	74.0	3.9
4 Dominus 5 gpa + Pic Plus 5 gpa	0	225	3830	0	11.0	59.7	14.8	5.9	1.0	21.8	65.0	23.5
5 Pic Plus 10 gpa	0	261	8991	0	11.8	84.4	23.3	6.9	2.0	32.3	71.0	3.0
6 Gwr Standard 12 gpa Telone	0	117	864	0	8.2	27.0	28.4	6.6	2.0	37.0	76.3	2.3
Average	0.0	284.3	3655.5	0.0	13.4	53.9	21.6	6.3	1.6	29.5	71.3	8.1
LSD 0.05	---	---	---	---	ns	31.1	11.6	ns	ns	13.4	8.5	13.0
CV, %	---	---	---	---	82.5	38.3	32.1	19.5	75	27	6.9	91.5

1) Statistical analysis only run on the square root transformed data.

2) Yield estimated from 2 row plot, 1000 lbs per bin. TMY = total marketable yield.

3) LSD 0.05 = Least Significant Difference at the 95% confidence interval. NS = not significant.

4) CV = coefficient of variation.

CDFA Fertilizer Research and Education Program 2014 Project

A. Project Information:

2014 CDFA/FREP Summary Report, 2014 cropping year (May – Dec, 2014).

Project Title:

PHOSPHOROUS AND BORON FERTILIZER IMPACTS ON SWEETPOTATO PRODUCTION AND LONG-TERM STORAGE

B. Objectives:

1. Evaluate different rates of soil applied phosphorous on sweetpotato crop response in soil, leaves, and roots to determine P rate recommendations for this crop.
2. Evaluate different rates of boron fertilizer on sweetpotato roots to determine impacts on yield and skin color after long-term storage.

C. Abstract

The last documented fertilizer trial conducted in California for phosphorus on sweetpotatoes was in 1974, and no trials evaluating crop response to fertilizer boron have ever been conducted in the state. The industry has changed substantially in the last 40 years, with increased use of compost, new varieties, drip irrigation, and much greater emphasis on long-term storage in order to meet customer expectations of having availability to sweetpotatoes year-round. Therefore, an on-farm fertilizer test was conducted in Merced County in 2014 to evaluate the response of sweetpotato cultivar ‘Covington’ to phosphorus and boron fertilizers. Treatment design was a randomized block split-plot with 4 replications. Phosphorus rates were the main plots; Boron rate was the split plot. Split size plot size was 6 rows (20 feet) by 30 feet long. The trial was transplanted on 6-May-2014 with the cultivar “Covington”. Phosphorus fertilizer, as MAP (11-52-0) was applied on 12-May by shanking in the dry fertilizer as a band on either side of the drip tape in the center of the bed to establish P_2O_5 treatments of 0, 50, 100, and 150 lbs/A. Ammonium sulfate and potassium sulfate were also added to each plot as appropriate so that applied N and K were equivalent. Boron fertilizer, as Granubor 14.3% B, was applied by hand down the center of the bed under the drip tape on 28-May and lightly incorporated. The amount of B varied by plot to establish treatment rates of 0, 1, 2, and 3 lbs B/A. Additional nitrogen and potassium fertilizer was applied through the drip tape during the growing season (liquid 10-0-10). Plots were harvested with a commercial mechanical harvester and sorted into #1, medium, and jumbo size categories. Means separations on the various response factors were done using Fishers protected LSD at $p=0.05$.

Pretreatment soil samples contained 46 ppm Olsen-P and 0.06 ppm B in the upper two feet of the profile, which would indicate that a response to additional P fertilizer would be unlikely, but that boron levels were low. Early season growth was reduced in the 0 lb/A phosphorous and boron plots as compared to the others plots, though this effect disappeared as the season progressed. In-season plant samples taken for B and P analysis showed some increased crop uptake of these nutrients as the rate increased, however the response was weakly polynomial with regression correlation coefficients (R^2) of only 0.3 – 0.56. There was a greater effect on leaf boron levels as fertilizer B increased as compared to phosphorous, but there was no significant effect on the plant canopy biomass from the boron treatments. Canopy biomass at harvest significantly increased from 20,000 lbs/A to 30,000 lbs/A in the plots with the highest rate of P (150 lbs P_2O_5 per acre), and all fertilizer rates had greater P concentration in the canopy compared to the 0 rate. Fall soil samples showed few differences, however, to the different rates of applied P or B, and there was no correlation between fall soil test values and yield. Overall yields were very good in this field, with total marketable yield averaging over 56 bins/A, but only the jumbo size category

displayed a significant response to added P, with more jumbos at 150 lbs P_2O_5 per acre as compared to the 0 rate. As a result, there was a significant inverse relationship observed in the economically important No. 1 category, with the highest percentage of No. 1's (60.3%) at the 0 lb/acre P rate. On average, P removal by the harvested roots was 1.3 lbs P_2O_5 per 1000 lbs (1 bin). At this location, the amount of P partitioned between the canopy and roots was 25.0 lbs P_2O_5 and 75 lbs P_2O_5 per acre, respectively. In general, the lack of response in this trial indicates that additional work on the method of application, especially for boron, is needed. Samples are being evaluated for treatment effects in storage.

D. Introduction

Sweetpotatoes are a growing industry in the U.S. They have received much positive publicity in the last few years regarding their nutritional benefits; additionally the production of sweetpotato fries has been a consumer success that is growing each year. In 2012, California was the second top producing state, harvesting approximately 21% of the national production from 18,500 acres (approximately 650 million pounds). The estimated farm value of the sweetpotato crop in 2011 was nearly \$130 million. This project addresses two issues currently facing the industry in California: 1) very little information regarding phosphorous requirements for this crop; and 2) a skin discoloration problem in the main cultivar that Extension Specialists in other states have suggested appears to be boron deficiency.

Multi-year fertilizer trials conducted with sweetpotatoes, including one such FREP sponsored trial in 2001 – 02, with nitrogen and potassium have provided information regarding rates, timing, source, and impacts on storage quality (the most recent report is in the 2009 Sweetpotato Research Progress Report, available online at <http://cemerced.ucdavis.edu>). Since that first work ten years ago, the industry has changed substantially, with increased use of compost, new varieties, and much greater emphasis on long-term storage in order to meet customer expectations of having availability to sweetpotatoes year-round. Additional issues within the industry include:

- Phosphorous rate determination and nutrient removal in the stored crop. The last documented fertilizer trial conducted in California for P on sweetpotatoes was in 1974. No yield response was observed, however, soil P levels were not determined. In the Fertilizer Guide for California Vegetable Crops¹, the suggested phosphorous rate for sweetpotatoes is 60 – 120 lbs P_2O_5 per acre. Based on root analyses from my own work, phosphorous is removed at the rate of 1.0 lb P_2O_5 per 1000 pounds of harvested roots. Average yields are about 31,000 lbs/A; high yielding fields are 60,000 lbs/A. Thus the current recommendation may be too high.
- Boron impacts on root quality and long-term storage. A new variety, Covington, now the dominant variety used in California, has problems after 6 months of storage with darkening of skin (“tea staining”) and dark spot formation that suggests boron deficiency (Figures 1 and 2, below). No Boron recommendations are made for sweetpotatoes in California, but fertilizer guidelines from other states suggest 0.5 – 1.0 lbs B per acre (NC Sweetpotatoes, Borax 2012).

Because of the lack of information on these two nutrients in California, a fertilizer rate trial was conducted in a commercial sweetpotato field in 2014. This project addresses two of FREPs priority research areas: Demonstrating agronomically sound uses of fertilizing materials at the field scale, and developing best management practices and education materials.

¹ Tyler, K.B., and O.A. Lorenz. 1981. Department of Vegetable Crops, University of California.



Figure 1 (left): dark spots on the left suggest B deficiencies, though the biotic pathogen Scurf may also be involved. **Figure 2 (right):** though subtle, this root is turning dark and becoming unmarketable in storage.

E. Description:

Project was located within a commercial sweetpotato field on the north east corner of Linwood Road and the Turlock main canal, near Delhi on the Merced-Stanislaus county line. Initial fertilizer treatments were on May 2, 2014, with the application of pre-plant, banded 8-8-8 fertilizer by Simplot at 60 gpa to certain plots within the project site. The fertilizer was applied as two bands, about 9" deep and 9" off-center in the bed. This application established the baseline P fertilizer levels at 50 lbs P_2O_5 per acre throughout most of the plot area except the untreated control. Additional P fertilizer, as MAP (11-52-0) was applied on May 12, 2014, by shanking in the dry fertilizer as a band on either side of the drip tape in the center of the bed (Figure 3). The amount of MAP applied varied by plot to establish P_2O_5 treatments of 0, 50, 100, and 150 lbs/A. These rates were slightly higher than originally proposed to better match current industry practices. Ammonium sulfate and potassium sulfate were also added to each plot as appropriate so that N and K were equivalent (season total 170 lbs N and 250 lbs K_2O per acre equivalent).

Boron fertilizer, as Granubor 14.3% B, was applied by hand down the center of the bed on May 28 and lightly incorporated, after which the drip tape placed on top (Figure 4). The amount of B varied by plot to establish B treatment rates of 0, 1, 2, and 3 lbs/A. These rates were higher than originally proposed based on discussions with growers and currently used rates that vary from 0.5 to 6 lbs B/A. Additional nitrogen and potassium fertilizer were added by the grower through the drip tape throughout the growing season (approximately 100 lbs per acre by mid August from 10-0-10 liquid formulation).

Treatment design is a randomized block split-plot with 4 replications. Phosphorous rates are the main plots; Boron rate is the split plot. Split-plot size is 6 rows (20 feet) by 30 feet. All data (plant and soil samples, yield) were taken from the center 2 rows. There were 64 total plots, and total trial size is 0.88 acres. Sweetpotato variety "Covington" was planted on May 6 using the growers labor and equipment at standard 12" plant spacing (about 13,000 plants per acre). This variety has had more problems with long-term storage and possible B deficiencies than other cultivars. The field was drip irrigated by the grower to maximize production (water was not a limiting factor) from transplanting until the end of August.

Irrigation water samples and the first leaf samples were taken on June 23. Leaf and petiole samples consisted of 20 leaves selected randomly from the center 2 rows of the plot, 6th leaf back from the growing tip. These were air dried at 50° C for one week, then submitted to ANR labs at UC Davis for

nutrient analysis (P & B) using standard lab methodology. A second leaf sampling was done on July 28 using the same procedure. One-half of the plots were soil sampled (0-12") on August 15, air dried, and submitted to ANR labs for P (Olsen P determination) and B analysis. To estimate the amount of nutrients in the canopy by the end of the season, whole plant canopy samples were taken from selected plots (16, such that there were samples from all four P and B rates) on August 29 by cutting a 35 ft² area from the center plot. The canopy was removed at ground level and weighed, then a sub-sample taken for moisture content and lab analysis (Figures 5 and 6).

Plots were harvested with a commercial mechanical harvester on Sept 25 – 26, 2014, and sorted into #1, medium, and jumbo size categories. A 30 lb storage sample was taken at this time, and a 10-root lab sample was also taken to determine crop nutrient removal. At the lab, the samples were washed very thoroughly and left to dry overnight, then sliced with a 3mm slicing blade in a food processor, spread out on a wire rack and dried in a forced air oven at 55 °C. They dried perfectly in 2 days without cooking and about 75% loss in weight. The dried samples were then ground through a large Wiley mill.

Means separations on the various response factors were done using Fishers protected LSD at $p=0.05$. Storage samples were weighed at harvest again in February; additional storage data is planned for May.



Figures 3 (left) and 4 (right). Phosphorous treatments were shanked into the soil at 8" depth between the drip line and row of transplants. Boron was added later to each plot by hand to the center of the bed where the water from the drip tape could move it to the roots.



Figures 5 (left) and 6 (right). Canopy nutrient use estimates were made at the end of the season by weighing the vine from a 35ft² section of the plot, then taking a 1 lb sub-sample for nutrient analysis.

F. Results and Discussion:

The field location was selected for its proximity to canal water (TID), cultivar (Covington), and cooperators involvement. The site was typical for soil used for sweetpotatoes: sandy, low CEC, low E.C. and pH. Pretreatment soil samples contained 46 ppm Olsen-P and 0.06 ppm B in the upper two feet of the profile, which would indicate that a response to additional P fertilizer would be unlikely, but that boron levels were low. The water, being from the irrigation district, had no significant contribution to the nutrient status of this test. Initial soil test information and irrigation water quality are shown in Tables 1 and 2.

Early season growth was reduced in the 0 lb/A phosphorous and boron plots as compared to the other plots, though this was no longer apparent in August. Leaf, whole canopy, and root sampling results for P and B are shown in Table 3. Phosphorus and boron levels in the leaves were significantly increased as fertilizer rates increased on both sampling dates. Leaf tissue showed a strong linear correlation to applied boron, but this was weak with phosphorus (Figure 7).

No significant P fertilizer effect was observed in the whole canopy concentrations for phosphorus, though canopy biomass did significantly increase as P fertilizer increased. There was no biomass response to boron fertilizer, in either the canopy or the roots, but canopy concentrations did significantly increase as rates increased. The root analyses gave similar results: as fertilizer P and B increased, the concentration of these nutrients in the roots also significantly increased. In almost every case, there was no significant P x B interaction for any of the measurements made in this test. Adding phosphorus increased P in the plants, but had no effect on boron levels, and boron fertilizer increased B in the plants, but had no effect on phosphorus levels.

While P fertilizer rate had no significant effect on the canopy concentration of this nutrient, it did increase the amount of biomass at the end of the season. The overall affect was an increase in whole canopy phosphorus as P rates increased. In this trial and year, the crop canopy contained

about 28 lbs of P_2O_5 per acre in the 150 lbs P_2O_5 per acre fertilizer treatment. Similarly, boron increased in the canopy, up to 0.2 lbs per acre (Figure 8).

Soil samples taken near the end of the growing season showed a significant increase in boron at the highest rate (only the 0 and 3 lb per acre rate were sampled), but no response to added phosphorous (Table 4). Results for phosphorus ranged from 25 – 45 ppm – well above the sufficiency level suggested for this crop.

Root yields and the estimated nutrient removal by the harvested roots were modestly affected by the fertilizer treatments in this study (Table 5). The No. 1 grade, which returns the most money to the grower, actually decreased as the P fertilizer rate increased, though the number of jumbos significantly increased and as a result, total yields were highest in the plots that received 150 lbs P_2O_5 per acre. The rate of boron did not have an effect yield. P removal in the roots was not significantly increased as the fertilizer rate increased, and averaged 75 lbs P_2O_5 per acre across all treatments. The lack of yield response is not surprising, given the high amount of P in the soil at this location, but yield responses to P in sweetpotatoes has been found to rarely occur in other trial locations across the U.S.

No correlation between P and B content in the roots and weight loss in storage was observed after 5 months (Table 5), however, some roots were already beginning to develop similar storage problems (blister, tea staining) that initiated this trial in the first place.

The amount of P_2O_5 removed by the roots was determined to be about 1.3 lbs per 1000 lbs of marketable yield (Figure 9). This figure compares favorably with other studies in the US that have shown P_2O_5 removal ranges from 1.0 – 1.5 lbs per 1000 lbs of harvested roots.

G. Discussion and Conclusions

In general, there was a crop response to increasing rates of both P and B fertilizer in this trial: as rates increased, so did the amount of these nutrients in the canopy and roots. However, there was no significant total marketable yield response, and therefore no optimal rate of either nutrient could be determined. The lack of yield response was likely because this site location had high soil test P levels well above established guidelines for either warm season (> 12 ppm Olsen P) or cool season (>25 ppm Olsen P) crops.

It is difficult to interpret the boron results. Clearly the plants were picking up the additional B as rates increased (Figures 7 and 8), however the amount found in the roots was very low, less than 10 ppm regardless of treatment, and the estimated amount in the roots (0.1 lbs per acre) and canopy (0.2 lbs per acre) is far less than what was applied. Further adding to the puzzle is the end of season soil B test in the untreated plots was far higher than the initial soil tests (0.47 vs 0.06 ppm), which is within the sufficiency range for most crops.

Overall yields were very good in this field, with total marketable averaging over 56 bins/A, but only the jumbo size category displayed a significant response to added P, with more jumbos at 150 lbs P_2O_5 per acre as compared to the 0 rate. As a result, there was a significant inverse relationship observed in % No. 1's, with the highest percentage of No. 1's (60.3%) at the 0 lb/acre P rate. On average, P removal by the harvested roots was 1.3 lbs P_2O_5 per 1000 lbs (1 bin). At this location, the amount of P partitioned between the canopy and roots was 25.0 lbs P_2O_5 and 75 lbs P_2O_5 per acre, respectively. In general, the lack of response in this trial indicates that additional work on the method of application, especially for boron, is needed. Samples are being evaluated for treatment

effects in storage. At 5 months, weight loss was 8.5% and symptoms of boron deficiency were just starting to appear only in the 0 and 1 lb boron treatments (Figure 10).

H. Project Impacts

One of the main objectives of the trial was to evaluate the impact of different rates of boron on storage quality. Long-term storage data will not be available until June, 2015.

Other potential impacts. Nutrient needs of the crop for the canopy, and what is removed at harvest. This trial needs to be repeated to confirm, but the data suggest 100 lbs of P_2O_5 per acre are needed annually, of which 75 lbs per acre are being removed in an average yielding crop.

Project's contribution toward advancing safe and sound use of fertilizer: no yield response to fertilizer P is expected when soil tests levels are > 40 ppm Olsen-P. When needed, a reasonable P fertilizer application rate would be 60 – 75 lbs per acre, depending on expected yield. There may be an interaction between P and nitrogen and potassium, as the data also suggest that N and K in the plants increased as P fertilizer increased.

I. Outreach.

Results of this work were presented at the following events:

2014 FREP/WPHA Conference, October 30, 2014, Modesto, CA. Phosphorus and Boron Fertilizer Impacts on Sweetpotato Production. A 20 minute presentation giving preliminary results to about 120 people, mostly CCAs, university, and CDFA-FREP personnel.

National Sweetpotato Collaborators Group annual meeting, January 24-25, 2015, Nashville, TN. 15 minute summary presentation of production results. Attendance about 40, mostly university specialists, students, and advisors working with sweetpotatoes.

50th Annual Sweetpotato Meeting, February 3, 2015, Merced CA. Quick summary of main results of this trial was given at this annual meeting. About 60 people in attendance, mostly growers and PCAs.

2014 Research Progress Report. Annual report of my research activities. To be posted to the Merced County UCCE website at <http://cemerced.ucanr.edu/Vegetable Crops/>

Literature Cited:

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NC Sweetpotatoes, 2014. Soils and fertilization. <http://www.ncsweetpotatoes.com/sweet-potato-industry/growing-sweet-potatoes-in-north-carolina/soils-and-fertilization/>.

Borax, 2012. Boron in vegetables. http://www.borax.com/docs/crop-guides/rtm-cg-vegetables_final-feb2012.pdf?sfvrsn=2.

Table 1. Sweetpotato P and B fertilizer trial, preplant soil samples (UC ANR analytical lab).

SAMPLE #	DESC	SP 200.02] %	pH 205.02] dS/m	EC 215.03] dS/m	Ca (SP) 235.04] meq/L	Mg (SP) 235.04] meq/L	Na (SP) 235.04] meq/L	Cl (SP) 227.02] meq/L	B (SP) 235.04] mg/L	NO3-N 312.03] ppm	Olsen-P 340.03] ppm	X-K 360.04] ppm	Zn (DTPA) 380.02] ppm	Mn (DTPA) 380.02] ppm	Cu (DTPA) 380.02] ppm	Fe (DTPA) 380.02] ppm
5	P trial 0-12"	23	6.21	0.62	4.54	1.01	0.56	0.93	0.06	6.50	44.1	39	2.9	13.5	4.8	62.9
6	P-Trial 12-24"	23	6.17	0.84	6.51	1.22	0.56	1.97	0.05	7.80	48.3	27	0.8	11.7	1.7	53.3

Table 2. Sweetpotato P and B fertilizer trial, Irrigation water analyses, June and July 2014.

SAMPLE #	DESC	NH4-N [SOP 847.03] mg/L	NO3-N [SOP 847.03] mg/L	pH [SOP 805.03]	EC [SOP 815.03] dS/m	SAR [SOP 840.02]	Ca (Soluble) [SOP 835.03] meq/L	Mg (Soluble) [SOP 835.03] meq/L	Na (Soluble) [SOP 835.03] meq/L	Cl [SOP 830.01] meq/L	B (Soluble) [SOP 835.03] mg/L
1	23-Jun	<0.05	<0.05	7.14	0.04	0.3	0.16	0.10	0.09	<0.10	<0.01
2	9-Jul	<0.05	<0.05	7.32	0.04	0.2	0.17	0.10	0.09	<0.10	<0.01
3	9-Jul	<0.05	0.05	7.34	0.04	0.3	0.17	0.10	0.09	<0.10	<0.01

Table 3. Phosphorus and boron content of sweetpotato leaves, canopy, and roots as affected by phosphorus and boron fertilizer treatment, 2014.

Treatment	June 24 leaf sampling				July 28 leaf sampling				Aug 29 Canopy (whole plant)				Sept 20 Roots			
	Main Plot, P205 lbs/A	Total P, %	Total B, ppm	Total P, %	Total P, %	Total B, ppm	Total P, %	Total B, ppm	wt, lbs/A	Total P, %	Total B, ppm	biomass P205 lbs/A	Total P, %	Total B, ppm	biomass P205 lbs/A	B lbs/A
1	0	0.37	61.9	0.34	0.34	60.4	0.28	0.28	20,399	0.28	0.28	21.1	---	0.23	6.6	69.0
2	50	0.38	49.7	0.34	0.34	46.4	0.27	0.27	25,072	0.27	0.27	25.8	---	0.23	6.4	74.2
3	100	0.41	49.9	0.35	0.35	55.2	0.28	0.28	24,954	0.28	0.28	27.2	---	0.23	6.4	75.8
4	150	0.42	44.1	0.37	0.37	39.2	0.27	0.27	30,747	0.27	0.27	28.1	---	0.25	6.2	82.2
Average		0.40	51.4	0.35	0.35	50.3	0.27	0.27	25,293	0.27	0.27	25.5	---	0.23	6.4	75.3
Variance		0.0025	131.7	0.0004	0.0004	36.9	0.0004	0.0004	7.99E+06	0.0004	0.0004	14.6	---	0.0002	0.26	184.0
p-value		0.051	0.011	0.003	0.003	0.001	0.86	0.86	0.002	0.002	0.86	0.097	---	0.021	0.324	0.538
Split Plot, Boron lbs/A																
a	0.0	0.39	32.9	0.35	0.35	29.3	---	---	25,962	---	---	22.9	0.09	0.23	5.9	74.1
b	1.0	0.40	44.0	0.35	0.35	45.0	---	---	25,035	---	---	27.2	0.11	0.23	6.3	75.0
c	2.0	0.40	54.8	0.35	0.35	57.7	---	---	25,713	---	---	39.4	0.16	0.23	6.7	75.1
d	3.0	0.39	73.8	0.35	0.35	69.1	---	---	24,462	---	---	46.8	0.21	0.24	6.8	76.9
Average		0.40	51.4	0.35	0.35	50.3	---	---	25,293	---	---	34.1	0.14	0.23	6.4	75.3
Variance		0.0003	142.6	0.0001	0.0001	100.3	---	---	2.55E+07	---	---	41.2	0.0015	0.0001	0.14	28.4
p-value		0.339	0.001	0.896	0.896	0.001	---	---	0.97	---	---	0.001	0.004	0.351	0.001	0.521
P x B interaction		0.066	0.08	0.108	0.108	0.106	---	---	---	---	---	---	---	0.717	0.618	0.797
CV, %		4.1	23.2	3.5	3.5	19.9	7.43	18.8	11.2	7.43	18.8	15	27.6	4.5	5.9	7.1
																8.7

p-value = probability of significant treatment effect; values less than 0.05 indicate means are significantly different at the 95% confidence level.

--- not all plots were sampled, therefore these values could not be determined.

CV = coefficient of variation

Table 4. Treatment effects on soil P and B.

Treatment		Aug 15 soil sampling	
Main Plot, P205 lbs/A		Olsen P,ppm	B, mg/L
1	0	35.0	0.47
2	50	33.3	0.56
3	100	36.3	0.43
4	150	33.8	0.63
Average		34.60	0.52
Variance		21.1	0.08
p-value		0.586	0.532
Split Plot, Boron lbs/A			
a	0.0	34.9	0.38
b	1.0	---	---
c	2.0	---	---
d	3.0	34.3	0.67
Average		34.60	0.52
Variance		6.6	0.07
p-value		0.557	0.009
P x B interaction p-value		0.543	0.361
CV, %		7.4	51.1

p-value = probability of significant treatment effect; values less than 0.05 indicate means are significantly different at the 95% confidence level.

--- not all plots were sampled, therefore these values could not be determined.

CV = coefficient of variation

Table 5. Sweetpotato yield as affected by fertilizer treatments and estimated removal in crop, 2014

Treatment		Yield, bins/A (bin = 1000 lbs)			TMY		% No. 1's		Nutrient removal in roots, lbs/A				wt loss in storage, %		blister loss, %	
Main Plot, P205 lbs/A		#1's	Jumbo	Medium					Root N	Root P205	Root K2O	Root B	Feb-15	Jun-15		
1	0	31.2	16.2	4.4	51.7	60.6			115.7	69.0	225.2	0.09	9.1	15.6	18.5	
2	50	28.8	24.7	4.1	57.5	50.0			143.0	74.2	253.8	0.09	8.2	14.6	21.5	
3	100	32.2	20.3	4.8	57.2	56.7			133.2	75.8	269.3	0.09	8.5	15.0	17.4	
4	150	27.8	26.7	4.1	58.7	47.4			163.5	82.2	293.1	0.09	8.3	14.3	28.5	
Average		30.0	22.0	4.3	56.3	53.5			138.8	75.3	260.4	0.09	8.5	14.9	21.5	
Variance		9.5	32.9	1.3	70.2	41.4			539.5	184.0	2878.6	0.00006	0.62	1.40	113.8	
p-value		0.052	0.003	0.362	0.157	0.001			0.003	0.120	0.034	0.538	0.040	0.073	0.063	
Split Plot, Boron lbs/A																
a	0.0	30.5	20.4	4.2	55.2	55.8			141.2	74.1	253.2	0.08	8.7	15.4	45.7	
b	1.0	30.0	22.8	4.1	56.9	53.0			137.9	75.0	257.8	0.09	8.7	14.9	21.2	
c	2.0	30.4	21.4	4.5	56.4	54.4			134.6	75.1	262.0	0.09	8.4	14.8	10.4	
d	3.0	29.0	23.2	4.5	56.7	51.4			141.6	76.9	269.0	0.10	8.3	14.4	8.8	
Average		30.0	22.0	4.3	56.3	53.5			138.8	75.3	260.4	0.09	8.5	14.9	21.5	
Variance		9.5	11.1	0.4	11.7	20.8			186.7	28.4	863.9	0.0004	0.86	1.41	89.2	
p-value		0.496	0.09	0.182	0.493	0.055			0.447	0.521	0.479	0.001	0.419	0.113	0.000	
P x B interaction		0.402	0.034	0.074	0.224	0.097			0.801	0.797	0.221	0.161	0.389	0.144	0.019	
CV, %		10.3	15.1	14.5	6.1	8.5			9.8	7.1	11.3	8.7	10.9	8.0	43.8	
US #1's	Roots 2 to 3.5 inches in diameter, length 3 to 9 inches, well shaped and free of defects.															
Medium	Roots 1 to 2 in diameter, 2 to 7 inches in length.															
Jumbos	Roots that exceed the size requirements of above grades, but are marketable quality.															
Mat Yield (TMY)	Total marketable yield is the sum of the above three categories.															
bins/A	Standard unit of yield in the industry, 1 bin = 1000 lbs.															
% US #1's	Weight of US #1's divided by total marketable yield.															
p-value	probability of significant treatment effect; values less than 0.05 indicate means are significantly different at the 95% confidence level.															
CV	= coefficient of variation															
blister	'tea stain' or blister like symptoms on roots in June (8 months storage)															

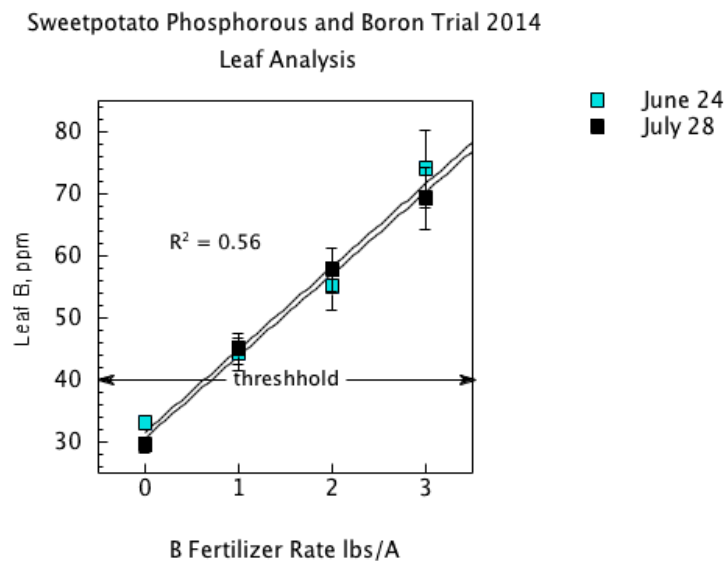
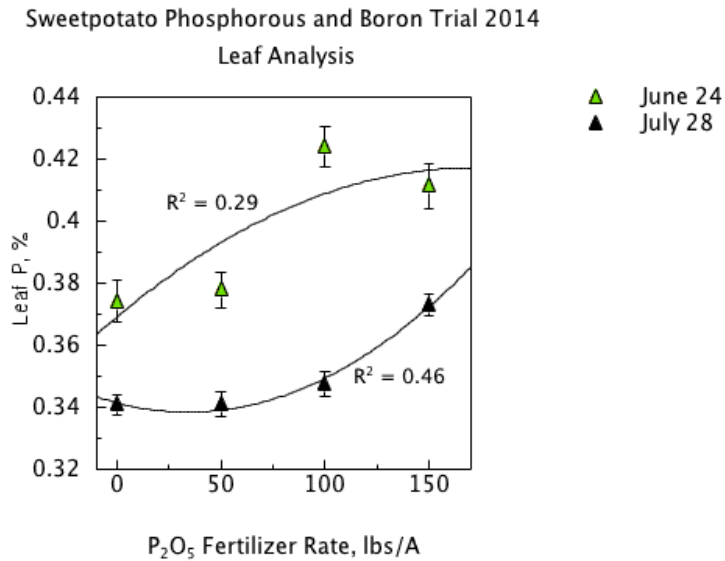


Figure 7. Phosphorus and boron levels in the leaves were increased as fertilizer rate increased on both evaluation dates. To improve clarity, data points show treatment average, however the regression was determined on individual plot data. Error bars show standard error of the mean.

Sweetpotato Phosphorous and Boron Trial 2014

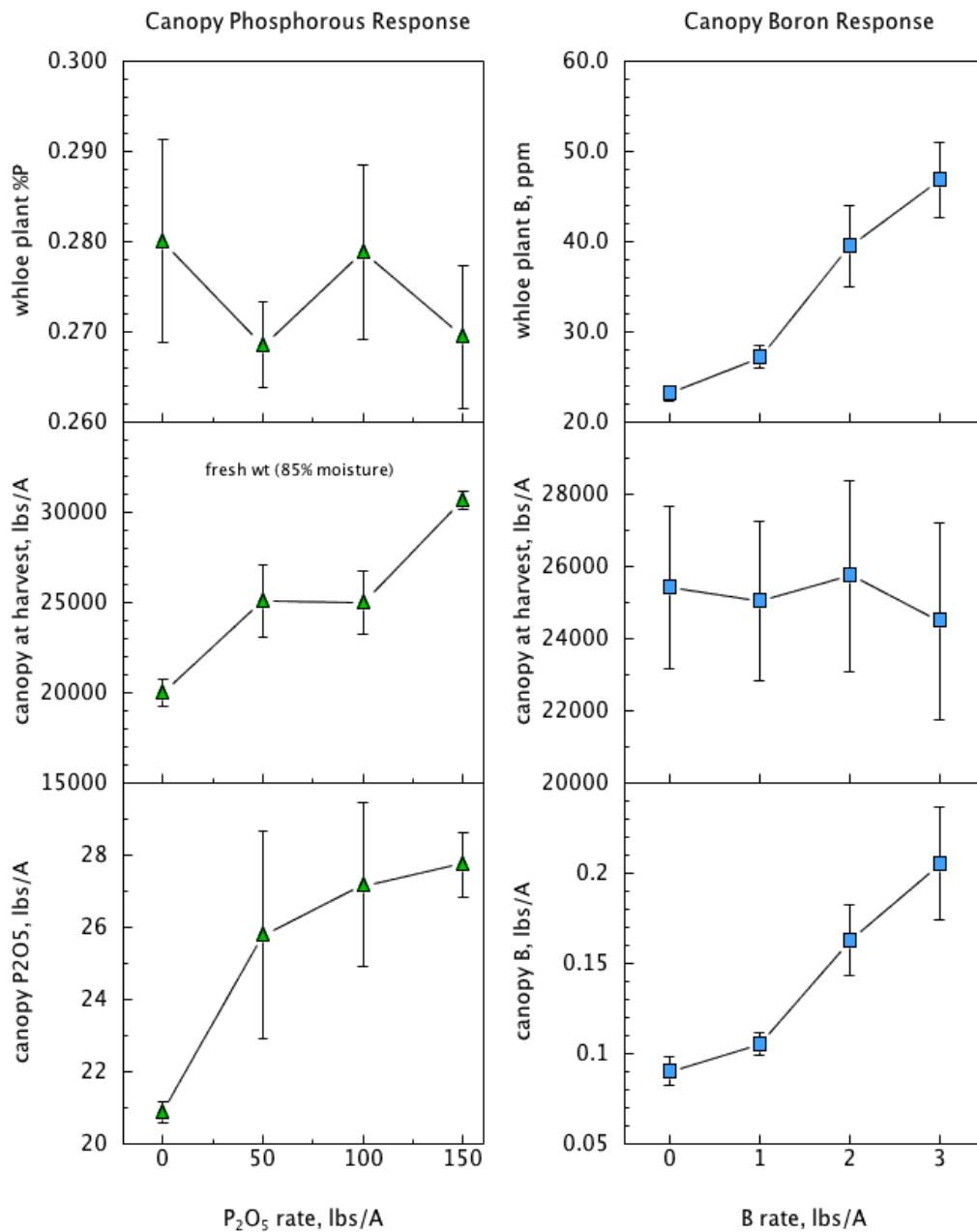


Figure 8. Whole plant P and B, canopy biomass, and canopy P and B nutrient content as effected by fertilizer rate. Error bars show standard error of the mean.

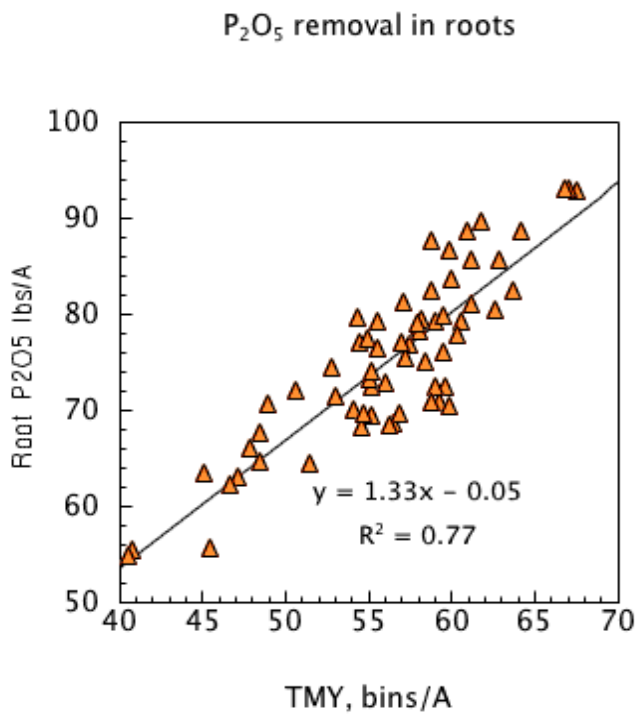


Figure 9. The relationship between total yield (TMY) and the amount of P₂O₅ in the roots was fairly well correlated, with 1.33 lbs removed per bin (1000 lbs).



Figure 10. Darkening and blister were beginning to appear after 5 months in storage.

CDFA Fertilizer Research and Education Program 2014 Project

Addendum, March 2016

C. Summary: long-term storage impacts (addendum to summary report submitted to FREP last year)

Treatments. An on-farm fertilizer test was conducted in Merced County in 2014 to evaluate the response of sweetpotato cultivar ‘Covington’ to phosphorus and boron fertilizers. Treatment design was a randomized block split-plot with 4 replications. Phosphorus rates were the main plots; Boron rate was the split plot. Phosphorus fertilizer, as MAP (11-52-0) was applied on 12-May at 0, 50, 100, and 150 lbs/A. Boron fertilizer, as Granubor 14.3% B, was applied by hand down the center of the bed under the drip tape on 28-May and lightly incorporated. The amount of B varied by plot to establish treatment rates of 0, 1, 2, and 3 lbs B/A.

Methods. At harvest on Sept 26, 2014, 30 lb root samples (#1 grade and free of blemishes) were taken from each plot, weighed, then placed into a commercial storage building for long-term evaluation. Ambient conditions for the duration of the storage test were monitored with two Hobo 012-011 temp/RH data loggers set to record hourly. Roots were evaluated on Feb 26 and June 10, 2015, for general weight loss (shrink) and development of “tea staining”/blister (characterized by a darkening of the skin and raised bumps) and other cosmetic problems and/or disease development (Figure 1). At the June evaluation, the root samples were weighed to determine overall shrink losses, then culled roots were removed and the sample reweighed to determine tea staining losses. Samples that had high % of problem roots were submitted to UC Davis DANR labs for boron analysis.

Results. Storage conditions for temperature and relative humidity (RH) were very good for the duration of the trial (9 months), with an average of 61.4° F and 71.8% RH (Figure 2). Weight loss in storage was 8.5% and 14.9% in February and June, respectively, and was not significantly affected by P or B treatments (Table 5). Darkening and blister-like symptoms were just beginning to appear in February in some of the samples, but there were few obvious problems at this time. At the end of the storage period, however, these symptoms significantly increased in the 0 and 1 lb/A boron treatments. Losses from tea staining and blister were nearly 46% where no boron fertilizer was applied (Table 5). Phosphorus rate had no significant affect on occurrence of these symptoms.

Root boron content in June had increased only slightly during the storage period, from 6.2 to 7.0 ppm (n = 16), therefore harvest B content of the roots was used for regression analysis. At harvest, boron concentration in the roots was increased as boron fertilizer rate increased from 0 to 3 lbs/A (Figure 3a). After 9 months storage, regression analysis showed a significant negative linear correlation ($p < 0.001$, $R^2 = 0.603$) existed between tea staining loss % and root boron content (Figure 3b), with losses greater than 20% when root B was < 6.5 ppm. Thus, boron fertilizer rate had a significant impact on reducing losses from tea staining. Quadratic correlation curves had fairly good fit ($R^2 = 0.645$) and indicate that 2 lbs of elemental boron per acre reduced the incidence of tea staining to about 10% (Figure 3c), with little further improvement at the higher 3 lb rate.

Discussion. Sweetpotato root samples were evaluated for phosphorus and boron fertilizer treatment effects in storage. At the February evaluation (5 months), weight loss was 8.5% and symptoms of boron deficiency were just starting to appear only in the 0 and 1 lb/A boron treatments. After 9 months in storage, however, symptoms of boron deficiency (tea staining and blister) were severe and significantly increased if the root B content in the roots was less than 6.5 ppm. Losses were significantly reduced by the application of more than 2 lbs/A of boron fertilizer in this trial because this rate increased boron in the

roots above 6.5 ppm on average.

Based on the results of this trial, the recommended rate of boron fertilizer for sweetpotatoes in California would be 2 lbs/A. However, this is based on only one site-year and location. Additionally, this rate is much higher than current guidelines in other states, which suggest 0.5 - 1.0 lbs B/A. California yields are about double that of the other states, therefore a doubling of boron rate would be anticipated. Complicating matters more, the occurrence of tea staining most predominantly occurs only in the Covington variety, and only when grown in certain areas. Thus, there may be a strong variety x environment interaction. Further work is necessary.

Acknowledgements. Many thanks to the following people for their cooperation with this test:

Paul Espinola, grower
Bob Weimer, equipment
Eddy Silveira, equipment
Lonnie Slaton, Simplot, fertilizer and custom application

This test would not be possible without the financial support of the CDFA FREP program.



Figure 1. Top. Weight loss after long term storage can result in pithiness developing in the interior of sweetpotato roots. Middle. Symptoms of boron deficiency include blister on the surface of roots. Bottom. “Tea staining”, which is a darkening of skin without blistering.

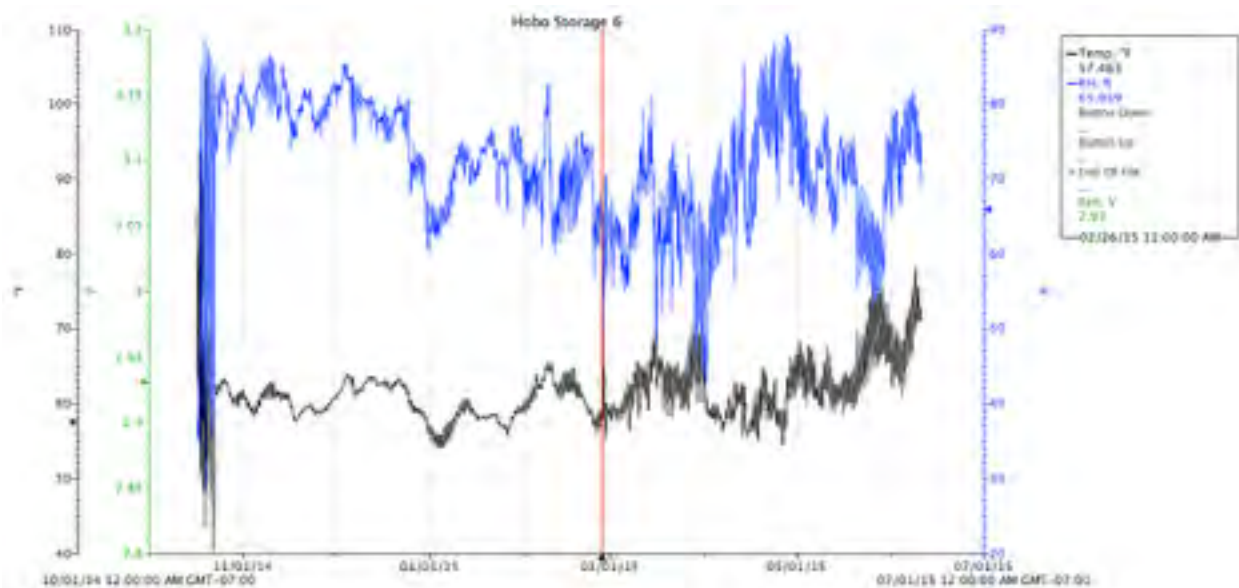


Figure 2. Relative humidity (%RH) and temperature (F) for the duration of the trial in the storage building was very good and close to recommended conditions for sweetpotatoes. Conditions after the February sampling (red line) had greater variability, which may be a factor in the accelerated onset of tea staining after this time.

Table 5. Sweetpotato yield as affected by fertilizer treatments and estimated removal in crop, 2014

Table 3. Sweetpotato yield as affected by fertilizer treatments and estimated removal in crop, 2014												
Treatment		Yield, bins/A (bin = 1000 lbs)				Nutrient removal in roots, lbs/A				wt loss in storage, %		blister loss, %
Main Plot, P205 lbs/A		#1's	Jumbo	Medium	TMY	% No. 1's	Root N	Root P205	Root K2O	Root B	Feb-15	Jun-15
1	0	31.2	16.2	4.4	51.7	60.6	115.7	69.0	225.2	0.09	9.1	15.6
2	50	28.8	24.7	4.1	57.6	50.0	143.0	74.2	253.8	0.09	8.2	14.6
3	100	32.2	20.3	4.8	57.2	56.7	133.2	75.8	269.3	0.09	8.5	15.0
4	150	27.9	26.7	4.1	58.7	47.4	163.5	82.2	293.1	0.09	8.3	14.3
Average		30.0	22.0	4.3	56.3	53.6	138.8	75.3	260.4	0.09	8.5	14.9
Variance		9.5	32.9	1.3	70.2	41.4	639.5	184.0	2878.6	0.00006	0.62	1.40
p-value		0.052	0.003	0.362	0.157	0.001	0.003	0.120	0.034	0.538	0.040	0.073
Split Plot, Boron lbs/A												
a	0.0	30.5	20.4	4.2	55.2	55.8	141.2	74.1	253.2	0.08	8.7	15.4
b	1.0	30.0	22.8	4.1	56.9	53.0	137.9	75.0	257.3	0.09	8.7	14.9
c	2.0	30.4	21.4	4.5	56.4	54.4	134.6	75.1	262.0	0.09	8.4	14.8
d	3.0	29.0	23.2	4.5	56.7	51.4	141.6	76.9	269.0	0.10	8.3	14.4
Average		30.0	22.0	4.3	56.3	53.6	138.8	75.3	260.4	0.09	8.5	14.9
Variance		9.5	11.1	0.4	11.7	20.8	186.7	28.4	863.9	0.0004	0.86	1.41
p-value		0.496	0.09	0.182	0.493	0.055	0.447	0.521	0.479	0.001	0.419	0.113
P x B interaction	p-value	0.402	0.034	0.074	0.224	0.097	0.801	0.797	0.221	0.161	0.389	0.144
CV, %		10.3	15.1	14.5	6.1	8.5	9.8	7.1	11.3	8.7	10.9	8.0

US #1's Roots 2 to 3.5 inches in diameter, length 3 to 9 inches, well shaped and free of defects.

Medium Roots 1 to 2 in diameter, 2 to 7 inches in length.

Jumbos Roots that exceed the size requirements of above grades, but are marketable quality.

Mkt Yield (TMY) Total marketable yield is the sum of the above three categories.

bins/A Standard unit of yield in the industry. 1 bin = 1000 lbs.

% US #1's Weight of US #1's divided by total marketable yield.

p-value probability of significant treatment effect; values less than 0.05 indicate means are significantly different at the 95% confidence level.

CV = coefficient of variation

blister 'tea stain' or blister like symptoms on roots in June (9 months storage).

FREP P&B Trial on Sweetpotatoes
June 2015 long-term storage results

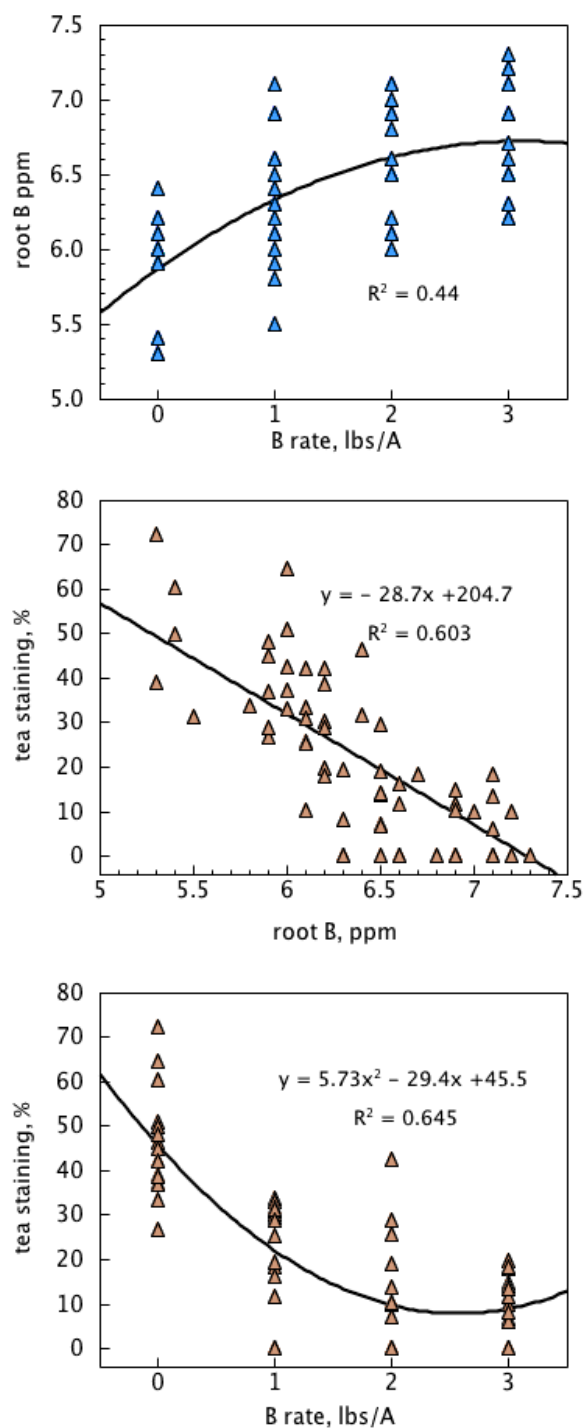


Figure 3. a). Root boron content at harvest increased as B fertilizer rate increased. b). Losses from tea staining after 9 months of storage were associated with reduced root B content. c). Losses from tea staining were significantly reduced with 2 and 3 lbs/A of fertilizer B.

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Many thanks to the many cooperators, including growers, PCA's, Agriculture Commissioner, and company development reps, for help with conducting these projects. Special thanks to the following cooperators & growers for putting in extra time and trouble:

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- Robert Garcia, Garcia Farms. Dominus fumigation trial.
- Blaine Yagi, Yagi Bros. Fungicide trial.
- Nathan and Nolan Mininger, Mininger Farms. Dominus fumigation trial.
- Nolan Mininger, Mininger Farms. Movento insecticide & nematocide trial.
- Bob Weimer, Weimer Farms. Cracking trial with Bellevue.