Changes in pH and Total Acidity of Sweetpotatoes Exposed to Wet, Cold Soil Conditions Before Harvest[1]

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Abstract. **Changes in pH and total acidity, comparable to those that occur in chilled roots during storage, take place in the field while the roots are still in the ground if wet, cold, soil conditions develop.**

Sweetpotatoes are harvested in the fall, usually before frost kills the vines and leaves, and before the soil becomes excessively wet. Occasionally harvests are made after the roots have been damaged by wet or cold soil conditions. Damaged roots store poorly, have objectional taste when cooked, and are unsatisfactory for "seed" (1,2,3). Although damaged roots contain high levels of CO_2, exhibit high respiration rates, and in some cases, flesh discoloration, these symptoms are not suitable for easy and accurate diagnosis of the extent of damage. A simple and quick means of determining damage could aid significantly in identifying roots unfit for marketing.

Recent tests demonstrated that chilling during storage produced changes in pH and total titratable acidity (4). Since chilling injury in storage produces other changes similar to those caused by wet or cold soil before harvest (2,3), observations were made to see whether wet and cold soil conditions also cause changes in pH and total titratable acidity. If so, these changes might provide a quick and easy test of damage. This paper reports the pH and total acid changes that occurred prior to harvest in roots of several sweetpotato cultivars during 3 years.

Roots were dug by hand on different dates during the 1966, 1967, and 1968 harvest seasons and pH and total titratable acidity were determined on 10-root samples of composited, mascerated tissue. In 1966 and 1967 the sweetpotatoes were grown at the Central Crops Research Station at Clayton, North Carolina in small, nonreplicated plantings; each digging was adjacent to the previous one. In 1968 the sweetpotatoes were grown at the Coastal Plain Vegetable Research Station at Faison, North Carolina, with varieties replicated 3 times in 30-ft plots. Successive diggings were made so as to obtain roots from adjacent hills within each replicate.

Roots were washed and dried after harvest and a portion was sliced from the center of each to prepare the composite 10-root samples. These 10 portions were passed through a food chopper (3/8-inch grid), and a 100 g sample was blended with an equal wt of water for 3 min. The puree was tested with a Beckman pH meter and titrated to an endpoint of pH 8.1 with 0.1 N sodium hydroxide.

Records from nearby weather stations were tabulated to show weekly rainfall and average maximum and minimum air temperature, and soil temperature at 7:00 AM at a depth of 4 inches under bare soil. The bare soil was judged to be similar to the sweetpotato fields after frost killed the vines and leaves. The 7:00 AM reading represented the approximate minimum for the day.

In September, 1966 the pH of 'Gem' and 'Nugget' roots was 6.08 and 6.16, respectively (Table 1), but increased to 6.24 and 6.25, by November 22 and then rose to over 7 by December 20. In September total titratable acidity was 2.46 and 2.57 m.e.q. per 100 g for

Table 1. pH and total acidity of sweetpotatoes dug at intervals in the fall of 1966, 1967, and 1968.

Cultivar	pH by date				Total titratable acidity (m.e.q./100 g) by date			
				1966[a]				
	9/27	10/17	11/22	12/20	9/27	10/17	11/22	12/20
Gem	6.08		6.24	7.30	2.46		2.08	.46
Nugget	6.16	6.20	6.25	7.60	2.57	2.07	2.40	.30
Avg	6.12		6.25	7.45	2.51		2.24	.38
				1967[a]				
	9/26	10/24		12/4[b]	9/26	10/24		12/4
Centennial	6.16	6.29		6.35	1.97	1.92		1.66
Nugget	6.39	6.28		6.77	1.52	1.21		1.31
Nemagold	6.16	6.03		6.20	1.86	1.59		1.50
Julian	6.30	6.23		6.56	2.13	2.02		1.79
Goldrush	6.33	6.25		7.20	1.52	1.37		1.23
Gem	6.37	6.33		6.58	1.31	1.60		1.35
Porto Rico	6.33	6.22		7.00	1.50	1.39		1.12
Avg	6.29	6.23		6.67	1.69	1.59		1.42
				1968[c]				
	9/26	9/19	10/30	11/20	9/9	9/19	10/30	11/20
Centennial		6.24		6.57		3.02		2.29
Nugget		6.30		6.48		2.57		1.92
Nemagold		6.30		6.46		2.56		2.10
Julian		6.21		6.42		3.46		2.63
Goldrush	6.15	6.25	6.24	7.02	2.77	2.54	2.44	1.39
Avg		6.26		6.60		2.83		2.07

[a]Successive samples of each cultivar from adjacent hills in the same row, all cultivars in adjacent rows in the field.

[b]Three varieties sampled Nov. 20 showed little or no change since Oct. 24.

[c]Avg of 3 replicates with roots harvested successively from adjacent hills in each replicate.

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'Gem' and 'Nugget', respectively, and decreased thereafter in a manner similar to the pH changes. The big changes in pH and total acidity for the period November 22 to December 20 occurred after the soil temperature had dropped below 50°F several times and the soil moisture was increased by a couple of inches of rainfall after the vines and leaves had been killed by frost (Table 2).

Similar but smaller increases in pH and decreases in total acidity were found with 7 cultivars in 1967 and 5 cultivars in 1968. In both years soil temperatures dropped below 50°F on several occasions and fairly heavy rains increased soil moisture greatly before the big shift in pH and total acidity occurred (Table 2).

In 1967 heavy rainfall during July and August caused some roots to develop symptoms of wet-soil injury, and in September the pH of 'Nugget' roots was higher and the total acidity lower than in September of 1966 and 1968, although a good rain fell after 4 weeks of dry weather just before sampling in September, 1966. Cultivar differences in pH and total acidity were sufficiently consistent to indicate the usefulness of these cultivars in studying response to wet, cold soil conditions.

Apparently, pH and total acidity changes comparable to those that occur in chilled roots during storage, take place in the field while the roots are still in the ground if wet, cold soil conditions develop. It is not clear whether wet soil or cold soil, or both, cause the changes. Further tests will be needed to clarify this and to determine whether the pH and acidity changes reflect the extent of damage well enough to serve as a guide in estimating the damage.

Table 2. Rainfall and avg weekly air and soil temperatures in the fall of 1966 and 1967 at or near Clayton, North Carolina, and in 1968 at or near Faison, North Carolina.

Year Weekly period	Rainfall (inch)	Air Temperature (F°) Avg maximum	 Avg minimum	Soil temperature at 7:00 AM at 4-inch depth[a] Weekly avg	 Weekly minimum
1966					
Aug. 7-13	1.14	86	70	77	76
Aug. 14-20	2.08	90	72	78	77
Aug. 21-27	.69	86	67	77	74
Aug. 28-Sept. 3	.02	89	65	75	74
Sept. 4-10	0	86	60	75	72
Sept. 11-17	.28	83	59	72	66
Sept. 18-24	3.09	79	61	69	67
Sept. 25-Oct. 1	1.40	82	59	69	66
Oct. 2-8	.05	70	48	65	62
Oct. 9-15	.02	79	53	64	60
Oct. 16-22	.52	73	49	61	56
Oct. 23-29	.04	73	48	60	57
Oct. 30-Nov. 5	.79	69	40[b]	54	48
Nov. 6-12	.67	71	49	55	50
Nov. 13-19	0	65	37	49	46
Nov. 20-26	0	64	38	46	43
Nov. 27-Dec. 3	.65	61	35	47	42
Dec. 4-10	.17	60	40	45	39
Dec. 11-17	1.41	54	34	44	39
Dec. 18-20	.01	55	37	43	42
1967					
Aug. 6-12	1.55	84	66	74	71
Aug. 13-19	.04	84	62	70	67
Aug. 20-26	3.05	89	67	75	73
Aug. 27-Sept. 2	2.16	82	63	71	65
Sept. 3-9	.25	81	55	68	66
Sept. 10-16	2.21	76	55	66	60
Sept. 17-23	.56	82	63	69	63
Sept. 24-30	.23	79	52	63	60
Oct. 1-7	.01	83	53	63	59
Oct. 8-14	.36	72	55	63	58
Oct. 15-21	.41	73	47	58	52
Oct. 22-28	.42	71	42	54	51
Oct. 29-Nov. 4	.15	69	45	53	49
Nov. 5-11	0	57	27[b]	45	42
Nov. 12-18	0	63	33	46	42
Nov. 19-25	.37	61	37	48	45
Nov. 26-Dec. 2	3.30	53	30	43	40
Dec. 3-4	.67	64	29	46	41
1968					
Aug. 4-10	.54	97	72	79	76
Aug. 11-17	.40	92	69	76	73
Aug. 18-24	1.28	97	72	80	78
Aug. 25-31	.17	85	60	75	70
Sept. 1-7	.22	88	65	73	70
Sept. 8-14	0	86	59	68	65
Sept. 15-21	0	84	54	68	67
Sept. 22-28	0	88	57	69	66
Sept. 29-Oct. 5	0	88	54	63	55
Oct. 6-12	.38	78	54	63	57
Oct. 13-19	2.21	70	63	65	63
Oct. 20-26	1.03	76	50	58	52
Oct. 27-Nov. 2	.07	70	38[b]	49	46
Nov. 3-9	.91	68	50	56	50
Nov. 10-16	2.28	58	35	43	39
Nov. 17-20	.45	67	45	49	41

[a]At Raleigh-Durham airport

[b]Frost killed most of the vines and leaves.

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