Time of Flooding and Cultivar Affect Sweetpotato Yield

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Abstract. The sweetpotato [*Ipomoea batatas* (L.) Lam] cultivars Jewel, Shore Gold, and Cordner, and the breeding line W241 were either 1) not flooded, 2) flooded for 5 days during midseason, or 3) flooded for 5 days just before harvest. Flooding just before harvest did not affect marketable yield, but flooding at midseason reduced marketable yield by 36% in 1989 and by 53% in 1990 and reduced the No. 1 grade yield by 46% in 1989 and by 57% in 1990. Marketable yield of 'Jewel' was higher than that of 'Cordner' in 1989, and that of 'Shore Gold' exceeded that of 'Jewel' in 1990. There were no interactions between flooding treatments and cultivars.

Sweetpotato production in the United States is located primarily in the southeastern and south-central states. This area has abundant rainfall, and the soil can become saturated at any time. Hurricanes and strong storms that strike the Atlantic and Gulf Coast states can flood sweetpotato fields, causing serious problems to producers. Kushman et al. (1954, 1958, 1959) reported that storage quality of 'Porto Rico' and 'Centennial' sweetpotato roots was adversely affected by excessively high soil moisture before harvest. Ton and Hernandez (1978) found that sweetpotatoes flooded for 72 h before harvest had more rot at harvest and increased shrinkage loss in storage than did nonflooded roots. Although flooding did not significantly affect total yield, there were differences among cultivars in the amount of rot at harvest and during curing. Ahn et al. (1980) found that four genotypes of sweetpotatoes exposed to 1 week of warm flooding (24 to 34°C) exhibited more root rotting during curing and storage than did sweetpotatoes exposed to cold flooding (4°C), cold dry soil, or warm dry soil. Postharvest storage rot incidence was not affected by genotype. Collins and Wilson (1988) found that damage to sweetpotatoes flooded in 1984 depended on the cultivar, with the percentage of flood-damaged roots varying from 0.2% to 38% of the total harvested roots. There was little additional root rot during storage.

In the previous studies, flooding just before harvest did not affect yield, but various

cultivars responded differently to flooding with respect to curing and storage. There is no information on how flooding earlier in the season affects yield. This study was designed to examine the effects of flooding at two times during production on the yield of three sweetpotato cultivars.

The experiment was conducted in 1989 and 1990 on a Bernow fine-loamy, siliceous, thermic Glossic Paleudalf soil. The A horizon is a fine sandy loam, ≈ 30 to 35 cm deep, with a percolation rate of 5.1 to 15.2 cm·h⁻¹. The B horizon is a sandy clay loam, 125 to 165 cm deep, with a percolation rate of 1.5 to 5.1 cm·h⁻¹. Since percolation rates of these horizons differ, total drainage is limited by the B horizon, and water can collect above it.

The study was arranged in a split-plot design with four replications. Flooding treatments were the main plots and cultivars were the subplots. Flooding treatments included a control (no flooding), flooding half-way through the growing season (≈ 60 days after planting), and flooding just before harvest (≈ 113 days after planting). 'Jewel', 'Shore Gold', 'Cordner', and the breeding line W241 (U.S. Vegetable Laboratory, Charleston, S.C.) were used each year.

Main plots, 4.6 m long $\times$ 8 m wide, contained eight rows on 1-m centers and were separated lengthwise by 3-m alleys. Individual rows were bedded, each bed was ≈ 0.3 m wide and 0.3 m tall. Plants were spaced 0.3 m apart in each row. The outer two rows (rows 1 and 8) in each main plot were left unplanted, rows 2 and 7 were planted as guard rows, and rows 3, 4, 5, and 6 each received one cultivar per row.

Slips, obtained from roots bedded locally, were transplanted on 1 June 1989 and 8 June 1990. Fertilizer was applied preplant at (kg·ha⁻¹) 56N, 62P, and 154K from a 9N-10P-25K blend. Midseason flooding was imposed 7-11 Aug. 1989 and 30 July-3 Aug. 1990; late-season flooding was imposed 25-

29 Sept. 1989 and 24-28 Sept. 1990.

Earthen dams were formed at both ends of the plots to facilitate flooding. Water was directed into the alleys between rows through 3.8-cm-diameter irrigation laterals. Flooding was maintained so that water levels were kept at or near the top of each raised bed, with water ≈ 0.3 m deep in the alleys. Flooding was maintained for 5 days on the central six rows in each eight-row main plot. All four subplot rows (rows 3 to 6) and the two adjacent guard rows (rows 2 and 7) were flooded. There were two nonflooded, nonplanted guard rows (rows 1 and 8) between adjacent main plots. Tensiometers were used to monitor soil moisture tension in all treatments and to verify that flooding was maintained at the rooting level (20 cm depth) in the appropriate plots.

Harvests were on 13 Oct. 1989 and 22 Oct. 1990. Sweetpotato storage roots were graded and weights were recorded according to the following classifications: canners (2.5 to 5.1 cm in diameter, 5.1 to 17.8 cm long); no. 1 (5.1 to 8.9 cm in diameter, 7.6 to 22.9 cm long); Jumbo (>8.9 cm in diameter, >22.9 cm long); culls (>2.5 cm in diameter and misshapen or showing signs of decay). All roots <2.5 cm in diameter were discarded without being graded. The number of roots culled because of rots, cracks, or misshapen roots was determined. For data analyses, weights of canners, no. 1s, and jumbos were numerically combined into a "marketable" category.

Yield from plots flooded in late season was similar to yield of the nonflooded controls (Table 1). However, in both years, marketable and total yields for the midseason-flooded plants were significantly lower than yields from nonflooded or late-season-flooded plants. In 1989, differences occurred primarily with no. 1 and canner grades, and in 1990 with no. 1 and jumbo roots. The marketable yield of 'Jewel' was higher than that of 'Cordner', and the total yields of both 'Jewel' and 'Shore Gold' were higher than that of 'Cordner'. 'Shore Gold' produced the highest total yield, primarily because of high yield in the jumbo category. There were no interactions between flooding treatments and cultivars in either year, but midseason flooding reduced the yield of all cultivars (interaction data not shown). When all cultivars were averaged, midseason flooding reduced the marketable yield by 36% in 1989 and by 53% in 1990 relative to the nonflooded control.

In 1989, culls made up $\approx 16\%$ of total yield. In that year, midseason flooding produced 23% culls vs. 12% for late-season flooding and 15% for controls. In 1990, culls made up $\approx 52\%$ of total yield. The percentage of culls in 1990 was generally unaffected by treatment, with midseason flooding producing 54% culls vs. 49% for late-season flooding and 53% for the nonflooded control. The number of cull roots categorized by cause (rots, cracks, or misshapen roots) was not significantly affected by treatment or cultivar.

Precipitation was 1010 mm in 1989 and 1830 mm in 1990. During the sweetpotato

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Table 1. Effect of flooding, time of flooding, and cultivar on yield of sweetpotatoes.

Variable	Yield (Mg·ha ⁻¹) ^a											
	1989						1990					
	Canner	No. 1	Jumbo	Cull	Marketable ^x	Total	Canner	No. 1	Jumbo	Cull	Marketable ^x	Total
Flooding												
None	4.11 a ^y	6.68 a	2.46 a	2.41 a	13.25 a	15.66 a	0.79 a	6.12 a	2.25 ab	10.46 a	9.16 a	19.62 a
Late-season	3.96 a	6.33 a	2.89 a	1.79 a	13.19 a	14.97 a	1.28 a	5.65 a	5.08 a	11.55 a	12.01 a	23.56 a
Midseason	2.53 b	3.64 b	2.30 a	2.60 a	8.47 b	11.07 b	0.76 a	2.61 b	0.96 b	5.07 b	4.33 b	9.40 b
Cultivar												
Jewel	3.28 b	7.44 a	3.58 ab	2.18 b	14.28 a	16.46 a	1.05 a	4.15 a	1.12 b	9.68 a	6.33 b	16.00 b
Shore Gold	2.28 b	4.81 b	4.10 a	4.03 a	11.19 ab	15.23 a	0.80 a	5.66 a	5.71 a	10.73 a	12.18 a	22.90 a
Cordner	2.54 b	3.97 b	2.14 bc	1.91 b	8.65 b	10.56 b	1.36 a	5.01 a	1.66 b	8.15 a	8.04 ab	16.19 b
W241	6.02 a	6.08 ab	0.54 c	1.05 b	12.64 ab	13.69 ab	0.58 a	4.33 a	2.55 ab	7.56 a	7.46 ab	15.01 b

^aThe flooding × cultivar interaction was not significant for any variable.

^bMean separation by Duncan's multiple range test, $P = 0.05$.

^cSum of Canner, No. 1, and Jumbo categories.

growing season (June-October) in 1989 and 1990, rainfall amounts were 510 and 560 mm. In one 5-day period in Sept. 1989, there was 174 mm of rainfall, and in a 5-day period in Sept. 1990, there was 207 mm of rainfall. Soil in all plots was at times saturated in the furrows, but not at the top of the raised beds. The 5-day duration of natural rainfall was similar to the duration of imposed flooding, but surface drainage was sufficient to prevent ponding of water above the surface of the furrow. Total yield in all treatments was low, and the percentage of culls was high, possibly because of the wet soil. There was an additional substantial reduction in yield with the plots flooded at midseason, but not at late season.

The reduction in final yield caused by midseason flooding appears to have been caused by the loss, presumably due to rot, of the existing storage roots. This position is supported by the tremendous reduction in U.S. no. 1s and jumbo roots in 1990, suggesting that the storage roots present at harvest were either sufficiently small during the stress period and/or were induced following flooding.

The lack of a yield response from late-

season flooding is consistent with other experimental reports. Our research shows that flooding at midseason in 1989 and 1990 resulted in a 36% and 53% reduction in marketable yield. The no. 1 grade, which normally has the highest value per unit, had a yield reduction from midseason flooding of 46% and 57% in 1989 and 1990, respectively. These yield reductions would have drastically reduced the economic return to the producer.

Late-season flooding has been shown to have detrimental effects on storage quality of sweetpotato roots. Although late-season flooding in this study did not reduce yield of marketable roots at harvest, the quality of roots following storage, which we did not evaluate for any treatment, could have been affected. Thus, the final effects of late-season flooding could be more detrimental than was shown here. Cultivars differed in yield, independent of flooding.

The amount of flooding imposed was extreme, but could occur under natural conditions. Additional research is needed to determine how much flooding, for how long, at midseason or at other times of the year

would detrimentally affect yield of various cultivars.

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