flowers. These results are in contrast to those of Moore and Scott (8) who reported the beneficial effect of deblossoming on runner production in both June bearers and everbearers. In fact when combined with the higher levels of N and GA_3 and lower level of ethephon, deblossoming decreased runner number by about 25%. Based on these results it is suggested that runner formation is physiologically independent of flower initiation and that deblossoming is of no practical value in runner production of 'Gem' everbearing strawberry. Although our results tend to substantiate those of Dennis (4) and Saha (10), further work involving a wider cultivar range is required before one can extend these findings to all everbearing strawberries.

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Heritability Estimates for Fiber Content, Root Weight, Shape, Cracking, and Sprouting in Sweet Potato[1]

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Additional index words. Ipomoea batatas, vegetable breeding

Abstract. **A parent-offspring test of 21 sweet potatoes (*Ipomoea batatas* (L.) Lam.) and 25 open-pollinated offspring from each provided heritability estimates ($h^2 \pm$ SE) for root fiber (0.47 ± 0.04), weight (0.41 ± 0.04, shape (0.50 ± 0.05), cracking (0.37 ± 0.04), and sprouting (0.37 ± 0.02). These characters were sufficiently independent to allow selection of one, or of any combination simultaneously, without adverse effects on the others.**

The sweet potato, a storage root, contains a vascular system (4) and acts as a sink for plant assimilates (12). The size and coarseness of the vascular elements after cooking varies quantitatively (5, 7, 14) and in some cultivars may be very objectionable. When objectionable, these elements are commonly referred to as "strings" or "fiber." It has long been recognized that cultivars vary in fiber characteristics (1, 2), a fact considered in selection for root quality (3, 8, 13). Fiber is associated with the cork cambium, vascular cambium, and anomalous cambium (4). Thus, there are two general locations for the fiber within the root; the outer portion or cortical region (the cork and vascular cambia) and a more central region (the anomalous cambium). Hammett et al. (7), in a study of 4 cultivars and various selfed and crossed progeny for them, concluded that fiber content and fiber size were separate but linked characters, with fiber content behaving as a quantitative character involving several genes and fiber size controlled by a few genes with partial dominance.

We have been following mass-selection breeding procedures (10) to incorporate high levels of resistance to wilt, nematodes, and soil insects in lines with high yield and market quality. Thirty selections are polycrossed each year, and the resulting seedlings are screened for cultivar potential. Recently a need for greater attention to root quality factors has been recognized (10). The purpose of this study was to obtain heritability estimates for fiber content, and other traits incidental to it, as an aid to selection for improved root quality in sweet potatoes.

Materials and Methods

In 1975, 30 sweet potato selections were planted in isolation from other flowering sweet potatoes and open-pollinated by naturally occurring insects. Twenty-five seedlings were obtained from each of 21 parents and used in a parent-offspring test. Sixteen parents were from mass-selection populations (Table 1), 4 (W-33, W-36, W-50, W-52) were selections from the 1974 polycross (PX) nursery and 1 (W-48) was a South Carolina Agricultural Experiment Station breeding line (SC 1166). Seedlings were started in the greenhouse during the winter and transplanted to the field in early spring. Ten vine

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Table 1. Comparison of sweet potato parental[z] (P), offspring[y] (O) and control means for fiber (anomalous and cortical), root wt, shape, cracking, and sprouting ability.

Parental line		Fiber content (1-5)[x]						Wt per plant (kg)		Shape (1-6)[w]		Cracking (1-5)[v]		Sprouting (0-5)[u]	
		Anomalous		Cortical		Index									
No.	Origin	P	O	P	O	P	O	P	O	P	O	P	O	P	O
W-178	W/1	3.00	2.65	3.33	2.75	3.17	2.70	1.26	0.94	3.33	3.96	2.00	2.12	2.00	2.96
W-2	W/2	2.83	3.09	2.83	3.21	2.83	3.15	1.26	0.79	3.00	3.60	3.33	3.16	5.00	3.17
W-3	W/4	2.83	2.89	2.83	2.99	2.83	2.94	1.09	0.78	2.33	3.52	3.33	2.48	2.00	3.21
W-4	H/3	2.71	3.34	2.95	3.29	2.83	3.32	0.78	0.89	3.33	3.60	3.66	2.92	3.00	3.58
W-8	I/3	2.83	3.08	2.93	3.25	2.88	3.16	1.03	0.82	2.33	3.04	2.66	3.52	5.00	3.16
W-9	I/3	2.83	2.96	3.21	3.01	3.02	2.98	1.14	0.77	2.66	3.28	3.33	1.64	5.00	3.88
W-11	I/4	1.60	2.61	1.66	2.61	1.64	2.61	1.35	0.89	2.33	3.32	1.00	2.44	5.00	3.26
W-12	I/4	3.83	3.22	4.00	3.31	3.91	3.26	1.30	0.85	2.33	4.08	1.33	3.00	2.00	2.20
W-13	I/4	2.88	3.26	2.95	3.32	2.91	3.29	0.80	0.71	4.66	3.60	2.00	2.12	4.00	2.52
W-15	I/4	3.26	3.40	3.73	3.45	3.50	3.43	1.12	0.60	2.00	2.84	1.66	2.60	3.00	2.69
W-23	I/5	3.61	3.50	4.05	3.63	3.84	3.56	0.94	0.71	3.00	3.56	2.66	2.44	5.00	3.24
W-33	Bulk PX-4	3.16	3.20	3.28	3.31	3.22	3.25	1.25	0.86	3.00	3.13	2.00	2.68	5.00	2.87
W-36	Ok-8-97 PX-4	3.45	3.20	3.45	3.21	3.44	3.20	1.06	0.88	3.66	4.12	5.00	3.48	2.50	2.85
W-39	I/1	1.46	2.79	1.51	2.85	1.50	2.82	0.64	0.68	2.00	2.69	3.66	2.62	2.00	3.12
W-41	I/6	2.83	3.34	2.83	3.50	2.83	3.42	1.17	0.77	3.33	3.40	2.00	2.32	5.00	3.68
W-42	I/6	3.66	3.13	3.66	3.19	3.67	3.16	0.72	0.69	2.33	3.08	4.33	3.12	5.00	3.37
W-45	I/6	2.60	3.12	2.83	3.29	2.71	3.21	0.98	0.83	3.00	2.88	1.66	2.16	5.00	4.16
W-48	SC 1166	2.66	2.68	2.78	2.81	2.71	2.75	1.41	1.06	2.00	3.20	1.00	1.80	3.00	2.94
W-50	W-178-PX-4	2.33	3.26	2.55	3.32	2.44	3.29	1.48	0.80	2.00	3.92	1.33	2.80	4.00	3.61
W-51	I/6	2.75	3.76	2.86	3.69	2.80	3.72	1.17	0.81	2.00	3.04	1.66	2.76	5.00	3.34
W-52	Bulk PX-4	3.16	3.40	3.28	3.48	3.22	3.44	1.34	0.73	2.66	3.06	2.00	2.89	4.00	3.77
Mean		2.87	3.14	3.02	3.21	2.95	3.17	1.11	0.80	2.73	3.38	2.46	2.62	3.88	3.22
LSD 5%		0.60	0.39	0.54	0.37	0.54	0.37	0.30	0.18	0.87	0.48	1.15	0.73	1.54	0.94
Controls															
W-54	W3-PX-4	3.28	2.73	3.28	2.87	3.28	2.80	1.06	0.91	2.33	2.80	1.33	1.40	2.00	2.66
Centennial		1.67	1.83	1.61	1.97	1.64	1.90	1.10	0.73	2.00	3.60	2.67	1.40	4.00	5.00
Jewel		1.16	1.40	1.22	1.40	1.19	1.40	1.47	0.82	3.67	4.60	1.67	2.60	5.00	4.66
SC 1149-19		1.16	1.50	1.22	1.57	1.19	1.53	0.98	1.00	2.67	3.00	2.00	1.20	5.00	5.00

[z]Three replicates of 10 plant plots.

[y]Ten plant plots of 25 offspring.

[x]Means from 6 roots per plot (2 judges, 3 roots each); 1 to 5 increasing fiber; fiber index = Anomalous + Cortical/2.

[w]1 = long & irregular, 2 = fusiform long, 3 = fusiform, 4 = fusiform short, 5 = short and nearly globular, 6 = round.

[v]1, no cracking, to 5, severe cracking.

[u]0 = no sprouting; 1 = very poor; 2 = poor; 3 = intermediate; 4 = good; 5 = excellent (uniformly vigorous sprouts, not replicated).

cuttings from each seedling were planted in a randomized block design on June 22, 1976, at the Edisto Experiment Station, Blackville, South Carolina. There were 5 replications, each consisting of plots of 10 vine cuttings from 5 offspring of each parent. Roots were harvested on Oct. 7 (107 days after planting). Vine cuttings from each parental line were planted on June 17 in 3 replications of 10-plant plots in the same field with the offspring. Roots were dug on Oct. 8 (113 days after planting). There were control plots in both plantings: 'Centennial', 'Jewel', and SC 1149-19, known to have acceptable fiber characteristics; and W-54, known to have objectionable fiber characteristics. Enlarged roots in each plot were rated for cracking (1 to 5, increasing severity) and for shape (1 = long and irregular; 2 = fusiform long; 3 = fusiform; 4 = furiform short; 5 = short and nearly globular; and 6 = round) prior to weighing. Two samples of three enlarged (as near US #1 size as possible) roots each were saved from each plot. The samples and remaining

Table 2. Heritability[z] estimates for root traits in sweet porato based on data from 21 parents and 25 open-pollinated progeny of each.

Root trait	$h^2 \pm SE$
Fiber content	
Anomalous	0.473 ± 0.044
Cortical	0.472 ± 0.038
Index[y]	0.477 ± 0.041
Weight	0.413 ± 0.039
Shape	0.502 ± 0.055
Cracking	0.374 ± 0.041
Sprouting	0.369 ± 0.016

[z]h^2 estimates from twice the regression of offspring means on parent means.

[y]Anomalous + Cortical/2.

Table 3. Correlations of means for sweet potato fiber index, root weight, root shape, root cracking, and sprouting.

Trait	Fiber index	Weight	Shape	Cracking	Sprouting
Fiber index	–	0.01	0.19	0.16	–0.01
Weight	–0.47*	–	–0.33	–0.62**	0.05
Shape	–0.05	0.37	–	0.25	0.06
Cracking	0.33	–0.15	0.15	–	–0.13
Sprouting	0.09	–0.05	–0.33	–0.19	–

*, **Significant at 5% (*) and 1% (**) levels, respectively. Parental correlations above diagonal; offspring, below; controls not included.

roots were cured and stored in paper bags under standard storage conditions (15).

Subjective fiber ratings were made after baking the roots for 2 hr at 176°C. Ratings were made by 2 judges working independently with the duplicate samples. Each judge evaluated 3 roots from each parent and offspring plot for fiber located in the center and in the cortex. Subjective fiber values of 1 to 5 were assigned at each location with 1 = none noticeable; 2 = present but not objectionable; 3 = slightly objectionable; 4 = objectionable; and 5 = very objectionable. The resulting 2 values were recorded separately and also were averaged to obtain a "fiber index." Thus, in Table 1 the central and cortical fiber means of parents are from 18 observations and offspring means represent 6 observations on each of 25 offspring from each parent.

All remaining roots from the parents and offspring were field bedded under black plastic at Charleston on March 21, 1977. Roots from controls were included once in the parent beds and 3 times within the offspring beds. The plastic was removed on April 18, and each line was rated subjectively on May 4 for degrees of sprouting from 0 (no sprouts), to 5 (uniformly vigorous sprouts).

Narrow-sense heritability estimates (h^2) were taken from twice the regression of offspring means on parent means (6). Correlations of trait means for parents and for offspring were obtained.

Results and Discussion

Comparison of the fiber content of the parents with that of the controls demonstrates a need to select for lower fiber content in our breeding program (Table 1). Fiber content in only 2 parents (W-11, W-39) was similar to that in the low-fiber controls; fiber content in most of the other parents did not differ from that in W-54, the high-fiber control. Root weights of parents were similar to the controls although 4 were lower (W-4, W-13, W-39, W-42). Shapes in all parents were acceptable although W-13 tended to be too short and globular. Seven of the parents had cracking scores above 3 and 8 parents had sprouting scores of 3 or lower, indicating some need for improvement in these characters.

The h^2 estimates (Table 2) for weight, shape, cracking and sprouting of roots were similar to previous estimates for these traits (9, 11). No previous h^2 estimates are available for fiber; the 3 in this study are nearly identical. Although none of the h^2 estimates are especially high, all are sufficient to be encouraging. Selection for low fiber content should be no more difficult than selection for any of the other traits studied.

The trait correlations indicate no unfavorable associations among the traits studied (Table 3). Parental fiber indexes were not correlated with any of the other measures. However, progeny with high average weight tended to have low fiber. Higher yielding parents also tended to have less cracking. Both of these associations are favorable for our selection goals. The absence of other correlations supports previous results (10) suggesting sufficient character independence to allow simultaneous selection for several.

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