nonpreference resistance to the cowpea curculio using the classical pedigree system of breeding a self-pollinated crop is likely to be slow if selections are made under field conditions. Early-generation single-plant selection schemes are likely to be quite inefficient because of low heritabilities and large variability in the curculio population from plant-to plant. Breeding systems, e.g. single seed descent (2), in which selection is delayed until after homozygosity is reached would allow more meaningful evaluations to be made on a family rather than a single-plant basis. Selection in the seedling stage could well be a practical alternative to field selection and a more definitive investigation into the relationship between seedling and pod preferences of the adult cowpea curculio is warranted.

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Influence of Nitrogen, Deblossoming, and Growth Regulator Treatments on Growth, Flowering, and Runner Production of the 'Gem' Everbearing Strawberry[1]

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Additional index words. Fragaria X *ananassa,* gibberellic acid, (2-chloroethyl) phosphonic acid, ethephon

Abstract. **Uniform everbearing strawberry plants (*Fragaria* x *ananassa* Duch. cv. 'Gem') were treated with 60 and 100ppm N, 50 and 100ppm gibberellic acid (GA_3), and 50 and 100ppm (2-chloroethyl) phosphonic acid (ethephon) in the greenhouse. One half of the plants were deblossomed as flowers emerged. Both GA_3 and N increased runner production and vegetative growth, independently and without interaction. Ethephon and deblossoming were generally ineffective on the measured characters except that 100ppm ethephon reduced leaf fresh weight and deblossoming increased inflorescence number. Highly significant interactions were observed among ethephon and higher levels of GA_3 and N. 'Gem' flowering and runner production appear independent of each other with deblossoming of no practical value in promoting runner production.**

Everbearing strawberries are shy runner producers. This is thought to be due to continuous initiation of flowers during the growing season and as a horticultural practice, flower buds are removed to favor runner production (3, 12), although one report indicated that this practice had no effect on runner production of 'Redcoat' ever bearing strawberries (4). Furthermore, suggestion has been made that flowering and runner production are independent processes (10). Several experiments have reported that GA_3 stimulates runner development (13) and inhibits flowering of strawberry (5, 11). N has been reported to increase runner production (2). The present experiment was designed to study the effect of N, gibberellic acid, ethephon, and deblossoming on runner production, growth and flowering of 'Gem' strawberries.

Materials and Methods

Eighty plants of the everbearer 'Gem', 12-14 g fresh wt, were planted in April 1977 in pots filled with potting compost and were grown in a glasshouse under natural long-day conditions of spring and summer with a mean temp of 22°C. Deblossoming, N, GA and ethephon were used at 2 levels each. Urea was added to bring the nitrogen level of the potting compost to either 60 or 120ppm. GA_3 and ethephon at 50 and 100ppm, were applied separately as aqueous solutions,

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2 weeks after planting. Inflorescences were retained on half of the plants, and were continuously hand removed, as they emerged, on the other half.

The experimental design was a 2^4 factorial with 5 replicates of 1 plant each. The pots were randomized and their positions regularly changed to minimize positional effects. Runner numbers were recorded 15 weeks after planting and leaf area, leaf fresh and dry wt, leaf number, total fresh wt, and root dry wt were determined at the termination of the experiment. Percent leaf N was determined by the microkjeldahl method.

Results and Discussion

N and GA_3 increased the runner number and vegetative growth significantly but had no effect on inflorescence number (Table 1). Percent leaf N increased with increasing N applied. GA_3 had an inhibitory effect on fruit set, a result similar to those of Guttridge and Thompson (6) and Porlingis and Boynton (9). Highest number of runners were produced when 120ppm N was combined with 100ppm GA_3 (Table 2). The effects of N and GA_3 were additive indicating that each promoted runner production independently. The beneficial effect of N on vegetative growth of strawberry is well established (1, 2, 7), however, the basic antagonism between vegetative development and inflorescence initiation, which on highly fertile soil tends to reduce yield from excessive vegetative growth (14), was not observed in our experiment.

Ethephon generally did not affect the measured characters except that it decreased leaf fresh wt (Table 1). This resulted from a highly significant interaction among GA_3, N, and ethephon. The $N_2G_2E_2B$ treatment significantly increased total fresh wt, root and leaf dry wt, and the leaf area and number over those of the $N_2G_2E_1B$ treatment (Table 2). However, treatment $N_2G_2E_2D$ increased dry wt, number and area of the leaves while it reduced leaf fresh wt by almost 43%, when compared with the $N_2G_2E_1D$ treatment. Plants receiving treatment $N_2G_2E_2D$ had about twice as many leaves as plants receiving treatment $N_2G_2E_1D$, since root growth was statistically the same for both groups, the individual leaves of the former group were thinner (no data presented) and contained less water and as a result, had less over all fresh wt.

Deblossoming did not increase number of runners produced, however, it stimulated inflorescence initiation. Our results indicated that blossoming was not competiting with initiation of runners, but instead it competed with initiation of new

Table 1. The main effects of chemical treatments and deblossoming on vegetative growth, runner production and flowering of 'Gem' strawberries.[z]

Treatments	Levels	Root dry wt. (g)	Leaf dry wt. (g)	Total fr. wt. (g)	Leaf fr. wt. (g)	No. leaves	No. runners	No. clusters	Avg leaf area (cm^2)	Leaf N (%)
N	60 ppm	2.4	2.7	21.1	11.8	11.4	7.4	4.6	28.3	1.7
	120 ppm	3.9	4.3	28.9	16.0	18.3	9.2	4.7	39.1	2.2
GA_3	50 ppm	2.0	2.1	16.1	8.3	9.7	6.4	4.4	23.3	1.9
	100 ppm	4.3	5.0	34.0	19.5	20.0	10.3	4.8	44.1	2.0
Ethephon	50 ppm	3.0	3.2	23.9	15.1	13.4	8.2	4.4	31.4	2.0
	100 ppm	3.3	3.8	26.1	12.7	16.4	8.5	4.8	36.0	1.9
Blossom	+	3.2	3.3	25.7	13.2	15.0	8.7	3.5	33.4	1.9
	–	3.1	3.8	24.3	14.6	14.7	8.0	5.8	34.0	2.0
LSD 5%		0.7	1.2	6.4	2.0	5.2	0.9	1.4	9.4	0.4

[z]Each figure is the average of 40 observations.

Table 2. The interactive effects of chemical treatments and deblossoming on vegetative growth, runner production, and flowering of 'Gem' strawberries.

Treatment	Root dry wt. (g)	Leaf dry wt. (g)	Total fr. wt. (g)	Leaf fr. wt. (g)	No. leaves	No. runners	No. clusters	Avg leaf area (cm^2)	Leaf N (%)
$N_1G_1E_1D$[z]	1.5gh[y]	1.1h	13.8g	7.6fg	7.0fg	5.3h	5.3ab	20.5gh	1.7cd
$N_1G_1E_1B$	1.6gh	1.2h	14.9g	7.3fg	8.8efg	5.5gh	3.0b	17.7h	1.5cd
$N_1G_1E_2D$	1.3h	1.7gh	17.3g	10.3efg	6.3g	5.3h	5.8ab	24.4fgh	1.3d
$N_1G_1E_2B$	1.8fgh	1.9gh	12.6g	6.0g	8.1efg	6.0fgh	3.3b	20.7gh	1.8bc
$N_1G_2E_1D$	2.5ef	3.4def	24.6ef	17.8cd	13.2de	8.8bcdef	5.8ab	40.7cde	1.7cd
$N_1G_2E_1B$	3.3cd	4.6cd	25.8e	15.2de	16.6cd	10.5abc	4.0ab	31.3efg	1.8bc
$N_1G_2E_2D$	3.4cd	3.7cdef	30.3cde	15.0de	16.5cd	9.3bcd	6.0ab	35.6def	1.8bc
$N_1G_2E_2B$	3.9bc	4.3cde	29.0de	15.0de	15.3cd	9.0bcde	4.0ab	35.8de	1.8bc
$N_2G_1E_1D$	2.7de	3.0fg	19.9fg	12.4def	12.5def	6.8defgh	4.5ab	23.0gh	2.3a
$N_2G_1E_1B$	2.7de	3.0fg	18.5fg	7.1fg	12.0defg	6.3efgh	4.0ab	25.3fgh	2.2ab
$N_2G_1E_2D$	2.2efg	2.4fgh	16.9g	8.1fg	11.8defg	7.8defgh	6.3ab	24.7fgh	2.2ab
$N_2G_1E_2B$	2.2efg	2.3fgh	14.9g	7.9fg	11.4defg	8.3cdefg	3.5b	30.2efg	2.2ab
$N_2G_2E_1D$	5.9a	4.6cd	35.0bcd	28.2a	17.3cd	9.5bcd	6.0ab	42.0cd	2.3a
$N_2G_2E_1B$	4.3b	5.1c	38.3b	25.5ab	19.8c	12.8a	3.0b	50.5bc	2.3a
$N_2G_2E_2D$	5.4a	6.4b	37.0bc	16.6cd	36.0a	11.5ab	7.0a	61.4a	2.3a
$N_2G_2E_2B$	6.1a	7.7a	51.1a	21.9bc	25.8b	11.3ab	3.0b	56.0ab	2.3a

[z]N_1 = 60ppm N, N_2 = 120ppm N; G_1 = 50ppm GA_3, G_2 = 100ppm GA_3; E_1 = 50ppm ethephon, E_2 = 100ppm ethephon; D = deblossomed and B = blossom retained.

[y]Mean separation in columns by Duncan's multiple range test, 5% level.

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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