

CULTURAL EXPERIMENTS WITH F₁ GERANIUM CULTIVARS¹

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The use of F₁ hybrid geranium seeds for plant production is the newest technique in the bedding plant industry. The potential value of the new seeded geraniums was indicated when several of the "Carefree" group received an All-American award for their performance in 1966. Further, plants grown from seeds are "disease free", provided that the plants are grown under sanitary conditions.

These new hybrid geraniums also initiated the concept of selling young nonflowering plants in packs like most bedding plants. Prior to the introduction of the seedling geranium, this plant had always been produced from cuttings and sold as a flowering potted plant. This concept opens an additional possible market outlet for the geranium and offers a shorter production schedule.

As with any new idea or concept, there are many questions on production techniques and many problems in scheduling the new crop. Some of these questions are: "Why should I grow seedling geraniums?" "When do I sow the seed?" "What particular care do they require?" "How do I handle them?" "What will they do?" "When will they bloom?" This report on research and observations here at the University of Minnesota should help answer some of the questions.

REVIEW

The Technical Service Department of George J. Ball, Inc. reported the following procedure. Seed was sown on January 25, seedlings were shifted to 1 3/4 inch "Jiffy Pots" on February 15, and to 4-inch pots on March 15. A temperature of 62° F. was maintained and the plants flowered in late May (approximately 115 days). In another trial, seed was sown directly in "Jiffy-7's" or in 1 3/4 inch "Jiffy Pots" and lighted at 1,000 ft. c. (cool-white fluorescent) for 24 hours a day starting 12 days after seeding. These plants flowered on April 28 or 94 days after sowing. Unlighted plants required an additional month to flower.

John White of Pennsylvania State University seeded plants on February 2, shifted seedlings into 2 1/2-inch pots on February 15 and shifted them into 4-inch pots on March 16. Plants were grown at 62° F. and were in flower on May 25 or 113 days after seeding. Height has been a problem with many growers. White sprayed the plants on March 22, which was 48 days after sowing, with a 2,400 p.p.m. concentration of Cycocel. Treated plants were still too tall by commercial standards.

Lindstrom of Michigan State University reported that 154.6 to 147.6 days were required for plants from a November 28 seeding date to flower. These plants were 9.2 to 11.2 inches in height. Plants which were pinched on March 15 flowered approximately the same date and in some cases earlier. These pinched plants were considerably shorter -- 4.8 to 5.8 inches tall. Lindstrom concluded that these F₁ Hybrid geraniums require high light intensities, since both the pinched and nonpinched plants flowered at approximately the same time.

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Materials and Methods

Seven selections of Carefree F₁ hybrid geraniums were grown. Seeding dates were December 15, 1966; January 15, 1967; February 15, 1967; and March 15, 1967. Seedlings were planted in 4-inch pots 15 days after seeding. Plants were grown at a night temperature of 60° F. in a normal, 1,000 and 2,000 ppm CO₂ atmosphere in the research greenhouses on the campus of the University of Minnesota. As the outside temperatures increased, the ventilators were opened. Hence, the CO₂ levels were maintained for a shorter and shorter period each day as spring approached.

Three cultivars from the December 15 and January 15 seeding dates were given a soft pinch on March 1 and April 1, respectively. Plants from the February and March seeding dates were not pinched. Monthly fresh and dry weights from three cultivars were taken from seedlings from all four seeding dates and three CO₂ levels. Plants were 2 1/2 months old from the date of seeding when the first harvest of vegetative growth took place. Harvesting was discontinued on June 1. As the first flower of each florescence opened, the date was recorded. The average bloom date was derived from the date of first bloom from each of the plants in all of the respective treatments. Plant height and number of shoots and visible buds were recorded on May 29, 1967. Those treatments not in flower by May 29 were planted in the field on June 7, 1967.

Extended photoperiods were applied to three of the cultivars from the February 15 and March 15 seeding dates. Two lighting treatments, incandescent (55 ft. c.) and cool-white fluorescent (55 ft. c.) were used from the time of potting to May 29. Plants were lighted from 10 p.m. until 3 a.m. All materials were given ample spacing as plant growth required. All materials were fertilized regularly according to soil tests.

RESULTS

Plants of the seven cultivars sown on December 15, 1966 flowered in 124, 116, and 111 days (average), respectively, with normal, 1,000 and 2,000 ppm CO₂ levels (Table 1). As the CO₂ levels increased, the number of buds, plant height, and number of shoots also increased (Table 1). Plants of the seven cultivars sown on January 15, 1967 flowered in 111, 106, and 99 days (average), respectively, with normal, 1,000 and 2,000 ppm CO₂ levels (Table 2). As the CO₂ level increased, the number of buds, plant height, and number of shoots also increased (Table 2). Plants from these two propagation dates (Tables 1 and 2) were tall on May 29. But they were well branched and balanced, as adequate growing space had been provided.

Seed sown on February 15, 1967 did not flower by May 29. On this date, the seven cultivars averaged 6.4, 6.6, 6.7 inches tall, respectively, in the normal, 1,000 and 2,000 ppm CO₂ levels. The average total number of buds present above the foliage was .4, .5, and .6 in the respective CO₂ levels. These plants were planted in the field on June 7 and were in flower by late June. Seed sown on March 15, 1967 were not in flower by May 29. On this date, the seven cultivars averaged 3.3, 3.3, and 3.8 inches tall, respectively, in the normal, 1,000 and 2,000 ppm CO₂ levels. No buds were evident above the foliage. These plants were planted in the field on June 7 and were in flower by the first week in July. By the start of July, plants from the last two propagation dates appeared quite similar.

Pinching delayed flowering in plants started on December 15 and January 15. On May 29, plants seeded December 15 and pinched March 1 averaged .3, 1.4, and 1.8 visible flower buds per plant, respectively, in the normal, 1,000 and 2,000 ppm CO₂ levels. Similarly, the average plant height was 7.0, 8.5, and 9.4 inches, and the average number of shoots per plant was 7.3, 8.2, and 8.7, respectively, in the three levels of CO₂. Plants started January 15 and pinched April 1 had no visible

Table 1.-Seedling geranium information. Seeded Dec. 15, planted in 4-inch pots January 3, data taken May 29, 1967 *

| Varieties | Bloom date | | | No. of flowers & buds ** | | | Height (inches) | | | No. of shoots | | |
|--------------|-----------------------|-------------|-------------|--------------------------|------------|------------|-----------------------|-------------|-------------|-----------------------|------------|------------|
| | CO ₂ (ppm) | | | CO ₂ (ppm) | | | CO ₂ (ppm) | | | CO ₂ (ppm) | | |
| | Normal | 1000 | 2000 | Normal | 1000 | 2000 | Normal | 1000 | 2000 | Normal | 1000 | 2000 |
| Scarlet | 5/4 | 4/26 | 4/19 | 3.2 | 3.2 | 5.8 | 8.8 | 11.8 | 12.9 | 2.2 | 2.4 | 3.0 |
| Red | 5/5 | 5/3 | 4/26 | 2.2 | 2.2 | 3.2 | 10.4 | 11.0 | 11.1 | 2.0 | 3.2 | 2.2 |
| Picotee | 5/6 | 4/26 | 4/24 | 2.4 | 2.6 | 3.8 | 10.1 | 11.3 | 11.8 | 2.4 | 2.2 | 2.3 |
| Bright Pink | 5/13 | 5/5 | 4/28 | 1.6 | 1.8 | 2.4 | 13.6 | 13.1 | 16.2 | 2.0 | 2.0 | 2.4 |
| Light Salmon | 5/5 | 4/29 | 4/21 | 2.8 | 2.0 | 5.2 | 7.8 | 7.5 | 9.0 | 2.0 | 2.4 | 2.4 |
| Dark Salmon | 5/10 | 5/2 | 4/29 | 2.5 | 2.4 | 4.6 | 10.0 | 10.8 | 12.2 | 2.5 | 2.0 | 2.4 |
| White | 5/15 | 4/29 | 4/28 | 1.2 | 1.8 | 2.8 | 9.5 | 10.9 | 10.8 | 2.0 | 2.2 | 2.0 |
| Average:*** | <u>5/8</u> | <u>4/30</u> | <u>4/25</u> | <u>2.3</u> | <u>2.3</u> | <u>4.0</u> | <u>10.0</u> | <u>10.9</u> | <u>12.0</u> | <u>2.2</u> | <u>2.3</u> | <u>2.4</u> |

* Average of 5 plants/variety/treatment.

** Average no. of flowers and buds which had developed by May 29, 1967.

*** Average of 35 plants/treatment.

Table 2.-Seedling geranium information. Seeded Jan. 15, planted in 4-inch pots February 2, data taken May 29, 1967.*

| Varieties | Bloom Date | | | No. of flowers & buds ** | | | Height (inches) | | | No. of shoots | | |
|--------------|-------------|-------------|-------------|--------------------------|------------|------------|-----------------|-------------|-------------|---------------|------------|------------|
| | Normal | 1000 | 2000 | Normal | 1000 | 2000 | Normal | 1000 | 2000 | Normal | 1000 | 2000 |
| Scarlet | 5/30 | 5/18 | 5/12 | 1.2 | 1.6 | 2.4 | 9.4 | 11.2 | 11.5 | 1.8 | 1.6 | 2.0 |
| Red | 5/24 | 5/20 | 5/10 | .6 | 1.4 | 2.0 | 8.9 | 10.7 | 11.1 | 1.4 | 1.4 | 2.4 |
| Picotee | 5/21 | 5/15 | 5/8 | 1.8 | 1.6 | 2.2 | 8.4 | 9.6 | 10.7 | 2.0 | 1.6 | 2.6 |
| Bright Pink | 5/28 | 5/20 | 5/14 | 1.2 | 1.2 | 1.4 | 9.6 | 13.1 | 12.9 | 1.4 | 1.2 | 2.2 |
| Light Salmon | 5/20 | 5/16 | 5/8 | 1.2 | 1.8 | 2.4 | 6.6 | 9.5 | 8.4 | 1.6 | 1.8 | 3.0 |
| Dark Salmon | 5/28 | 5/23 | 5/16 | 1.0 | 1.4 | 2.2 | 8.7 | 9.5 | 9.9 | 1.8 | 1.4 | 2.0 |
| White | 5/20 | 5/14 | 5/13 | 1.0 | 2.0 | 1.6 | 8.9 | 8.8 | 9.7 | 1.2 | 2.0 | 2.8 |
| Averages:*** | <u>5/24</u> | <u>5/19</u> | <u>5/12</u> | <u>1.1</u> | <u>1.6</u> | <u>2.0</u> | <u>8.6</u> | <u>10.3</u> | <u>10.6</u> | <u>1.6</u> | <u>1.6</u> | <u>2.4</u> |

*Average of 5 plants/variety/treatment.

** Average no. of flowers and buds which had developed by May 29, 1967.

*** Average of 35 plants/treatment.

flowers or flower buds on May 29. Average plant height was 6.5, 6.7, and 7.2 inches, and the average number of shoots per plant was 7.3, 8.3, and 8.7, respectively, in the three levels of CO₂.

Plants from the February 15 and March 15 seeding dates lighted with incandescent bulbs were taller than plants lighted with fluorescent tubes. The plants grown in the natural day length were the shortest (Table 3). There were more buds (.8 buds/plant) on the plants grown under the fluorescent lights than those grown under the incandescent lights (.4 buds/plant) when grown under the 2000 ppm level of CO₂ (Table 3). Visible buds were not present on plants in the other CO₂ levels or under the natural day length.

Monthly fresh and dry weight data are presented in Table 4. Note that the Scarlet seedlings, which were seeded December 15 and harvested March 1 (75 days old), had a fresh weight of 19.2 grams, 60.2 grams, and 82.0 grams, respectively, in the normal, 1,000 and 2,000 p.p.m. CO₂ treatments. The same cultivar seeded March 15 and harvested June 1 (77 days old) had a fresh weight of 126.2, 162.5, and 178.3 grams in the same respective CO₂ treatments. In the earliest seeding date, the differences in fresh weight were related to CO₂ treatments, which dramatically increased the fresh weights. In the last seeding date, the differences in fresh weight as related to CO₂ levels were not striking. This can be related to the fact that the ventilators were open more and more as the days became warmer. Increased natural light intensity and day length were more significant in the last seeding date when compared to the earliest seeding date. These weight comparisons demonstrate the great importance of light energy.

Observations

In all instances seed germination is most rapid. Evidence of germination can be seen frequently within 4 days. All seedlings were germinated in 2 inches of vermiculite on top of a well prepared soil mix. Seed up to 9 months old was viable. Older seed was not used in this study. Seedlings grew rapidly, and they should be transplanted as soon as they can be adequately handled. Caution should be taken to plant the seedling as deep as possible -- cotyledons should be quite close to the soil line. There is a sharp demarcation in the

Table 3.-Lighting Information. Height of geraniums grown in 2 photo periods with 2 sources of artificial illumination at 3 CO₂ levels. Data taken May 29, 1967 *.

| Varieties | Natural | | | Incandescent | | | Fluorescent | | |
|--|-----------------------|------|------|-----------------------|------|-------------------|-----------------------|------|------------------|
| | CO ₂ (ppm) | | | CO ₂ (ppm) | | | CO ₂ (ppm) | | |
| | Normal | 1000 | 2000 | Normal | 1000 | 2000 | Normal | 1000 | 2000 |
| Seeded February 15. Potted into 4" pots and lighted March 1. | | | | | | | | | |
| Scarlet | 6.4 | 6.5 | 7.1 | 8.7 | 9.0 | 10.0 _a | 6.2 | 7.1 | 7.4 _b |
| Bright Pink | 6.6 | 8.2 | 8.1 | 9.3 | 9.4 | 9.6 _a | 7.3 | 8.4 | 7.7 _b |
| Dark Salmon | 5.7 | 6.9 | 7.7 | 7.0 | 7.0 | 8.6 _a | 6.4 | 6.4 | 7.4 _b |
| Average ** | 6.2 | 7.2 | 7.6 | 8.3 | 8.5 | 9.4 | 6.6 | 7.3 | 7.5 |
| Seeded March 15. Potted into 4" pots and lighted April 1. | | | | | | | | | |
| Scarlet | 2.8 | 3.0 | 3.5 | 3.8 | 3.9 | 4.1 | 2.3 | 3.3 | 4.0 |
| Bright Pink | 2.7 | 3.5 | 4.1 | 4.1 | 4.9 | 5.1 | 3.1 | 3.5 | 3.1 |
| Dark Salmon | 3.0 | 3.5 | 3.8 | 3.4 | 3.7 | 4.1 | 4.0 | 4.1 | 3.4 |
| Average ** | 2.8 | 3.3 | 3.8 | 3.8 | 4.2 | 4.4 | 3.1 | 3.6 | 3.5 |

- a. Average of .40 buds 1 plant
 b. Average of .80 buds 1 plant
 No other treatments had buds visible.

* Average of 5 plant/variety/treatment.

** Average of 15 plants/treatment.

Table 4.-Fresh weight over dry weight information. Influence of CO₂ levels and time in the vegetative growth of F₁ Hybrid Geranium. * Figures represent fresh weight over dry weight two months after potting.

| Dates of Harvest | | Date Seeded | | | | | | | | | | | |
|------------------|---------|-----------------------|--------|--------|-----------------------|-------|--------|-----------------------|-------|--------|-----------------------|-------|-------|
| | | Dec. 15 | | | Jan. 15 | | | Feb. 15 | | | Mar. 15 | | |
| | | CO ₂ (ppm) | | | CO ₂ (ppm) | | | CO ₂ (ppm) | | | CO ₂ (ppm) | | |
| Variety | Normal | 1000 | 2000 | Normal | 1000 | 2000 | Normal | 1000 | 2000 | Normal | 1000 | 2000 | |
| March 1 | Scarlet | 19.2 | 60.2 | 82.0 | | | | | | | | | |
| | | 6.3 | 7.2 | 10.1 | | | | | | | | | |
| | Bright | 20.7 | 54.0 | 68.2 | | | | | | | | | |
| | Pink | 5.4 | 9.9 | 10.8 | | | | | | | | | |
| April 1 | Light | 18.0 | 47.4 | 99.4 | | | | | | | | | |
| | Salmon | 4.4 | 6.4 | 9.3 | | | | | | | | | |
| | Scarlet | 190.5 | 272.7 | 390.2 | 93.7 | 125.3 | 184.4 | | | | | | |
| | | 31.7 | 36.7 | 62.2 | 11.7 | 15.5 | 24.6 | | | | | | |
| May 1 | Bright | 193.9 | 228.7 | 392.6 | 112.2 | 139.9 | 192.5 | | | | | | |
| | Pink | 24.3 | 41.5 | 69.2 | 14.9 | 22.0 | 26.6 | | | | | | |
| | Light | 164.1 | 218.3 | 308.6 | 107.2 | 139.5 | 200.4 | | | | | | |
| | Salmon | 26.2 | 38.1 | 68.8 | 12.9 | 17.7 | 27.0 | | | | | | |
| June 1 | Scarlet | 448.8 | 576.6 | 807.3 | 327.4 | 363.2 | 627.1 | 92.3 | 108.7 | 138.9 | | | |
| | | 85.2 | 92.3 | 133.3 | 68.1 | 69.8 | 80.5 | 23.9 | 25.5 | 31.6 | | | |
| | Bright | 460.7 | 545.7 | 642.8 | 350.8 | 365.2 | 552.3 | 98.2 | 163.8 | 174.2 | | | |
| | Pink | 96.1 | 105.2 | 109.0 | 60.2 | 68.4 | 88.8 | 25.1 | 30.5 | 37.7 | | | |
| June 1 | Light | 403.9 | 453.8 | 714.6 | 340.6 | 362.9 | 547.9 | 132.0 | 145.4 | 156.4 | | | |
| | Salmon | 70.5 | 101.3 | 147.5 | 59.0 | 63.5 | 91.2 | 30.9 | 39.3 | 43.6 | | | |
| | Scarlet | 1111.4 | 1137.4 | 1150.7 | 732.5 | 823.1 | 922.9 | 432.8 | 448.1 | 466.9 | 126.2 | 162.5 | 178.3 |
| | | 151.2 | 199.7 | 254.2 | 115.7 | 130.5 | 164.4 | 80.3 | 82.5 | 83.6 | 29.5 | 31.7 | 34.4 |
| June 1 | Bright | 1023.7 | 1044.1 | 1310.9 | 603.6 | 694.3 | 1040.5 | 362.9 | 429.5 | 462.9 | 166.0 | 172.3 | 202.7 |
| | Pink | 198.3 | 221.7 | 264.7 | 131.7 | 146.7 | 188.7 | 83.7 | 90.1 | 92.3 | 28.2 | 28.2 | 29.0 |
| | Light | 850.1 | 854.9 | 1248.2 | 745.4 | 764.6 | 972.3 | 486.1 | 511.0 | 515.2 | 169.8 | 172.8 | 196.4 |
| | Salmon | 152.8 | 167.2 | 243.8 | 123.0 | 135.8 | 175.0 | 61.5 | 83.8 | 96.9 | 20.4 | 27.1 | 38.8 |

* Average dry and fresh weight of 5 plants/variety/treatment.

diameter between the stem and root. The lower stem and root is much smaller and must be below the soil surface. If a portion of the lower stem, which has a smaller diameter than the stem tissue immediately adjacent, is above the soil line after planting, the whole plant may snap off at the soil line when the plants become larger and are moved.

Plants derived from seed are disease free, and cuttings from these plants also should be disease free, provided sterile conditions are maintained. However, during the dark days of winter and when certain plants were over-watered, Pythium was observed in an occasional plant. In general, if sterile conditions are maintained and proper cultural practices are followed, disease should not present a problem.

In some rare cases, especially in the elevated CO_2 levels, splitting and proliferation of the flower stem occurred prior to the time the flower stem became straight. If this condition developed, the flower bud usually aborted. Again in the elevated levels of CO_2 , the flower head frequently send out stems or shoots, which developed into another inflorescence of a smaller size. Frequently, there were three or four of these "sub-florescences" from each original flower, primarily with the Scarlet cultivar. These were not unattractive, but did cause the stem holding the inflorescence to bend or collapse.

Conclusions

The advantages of seeded geraniums are numerous. Seedling geraniums offer a source of disease-free plants. Obtaining a source of disease-free cuttings is frequently a major problem to the producer. Disease-free cuttings are available only when grown in the greenhouse. Such cuttings are quite satisfactory, but the cost is appreciably higher than that of west coast field grown cuttings or hybrid seed. Further, the transportation cost is by far less for a packet of seed than for a shipment of cuttings. The color range is excellent.

Height control and length of time required to produce a plant in flower are other considerations. With the advent of more information on the use of lighting, increased levels of CO_2 , and growth retardants; these considerations will become less important. Further, new selections that will flower in less time should appear in the near future. The new concept of growing these seedling geraniums as bedding plants not in flower should open a

new market outlet. The economics of these F_1 hybrids are complex. Consideration of cuttings costs from a specialist in comparison to seed, the cost of maintaining stock blocks, and propagation-rooting areas must be accounted for in the cost of production. Further, the possibility of using cuttings from plants produced from seed, which will be disease free, has not been fully explored. Labor should always be considered, and direct seeding into $2\frac{1}{2}$ or 4-inch pots should be considered as a method to decrease labor costs.

These data, showing the various fresh over dry weights of the several cultivars from the four seeding dates and three CO_2 levels, demonstrate the requirement of high light intensities of the geranium. They also demonstrate that as the intensity and duration of light increased, the weights of plants greatly increase.

At the present time, if seeds are sown in Minnesota on or by January 1 and good cultural conditions (CO_2 and nutritional) are maintained, a flowering plant should be produced by the 30th of May. Considering the time involved and size of the plant, a 5-inch pot might be preferred to finish the crop.

Several other companies offer F_1 hybrid geranium seed. Because of space and manpower limitations, this study was limited to one source.

Literature Cited

1. _____ . 1967 Grower Talks Vol. 31, No. 4: 1-10, August
2. Lindstrom, Richard S. 1967 The Michigan Florist 439:12, September.