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Producing Seed Geraniums for Profit

—A Commercial Grower's Guide

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I. Introduction and History

A. Propagation of commercial geraniums from seed was made possible in 1965 with the introduction of the cultivar, *Nittany Lion Red* developed by The Pennsylvania State University. It was the first open pollinated cultivar that was true to type from seed.

B. The Moreton Series was developed by Harris Seed Company and introduced in 1966. This series was renamed the New Era Series in 1969.

C. The Carefree Series was introduced by Pan America in 1968.

D. The Sprinter variety was introduced in 1973 by Sluis & Groot/Goldsmith. At this time, seed geraniums became a significant part of the total geranium market.

E. Breeders continued to work on earlier flowering, compact plant growth and the reduction of petal shattering.

F. The Ringo Series was introduced in 1977 by Sluis & Groot.

G. Cherry Diamond and early flowering types were introduced by Waltz Seed Company of Germany in 1982.

H. Today there are over 150 different cultivars on the market ranging in time to flower from 70 to 140 days.

I. In 1984 over 150,000,000 seeds were sold to produce this crop in the United States and Canada.

II. Cultivars

Name, Year Introduced and Developer

Apple Blossom Orbit	1982	Goldsmith
Apple Blossom Orbit Improved	1984	Goldsmith
Bright Eyes	1980	Goldsmith
Cameo	1981	Ball
Capri Brick Red	1981	Farmen
Capri Deep Red	1981	Farmen
Capri Scarlet	1981	Farmen
Capri Stella	1981	Farmen
Capri Tropical Salmon Rose	1981	Farmen
Capri White	1981	Farmen
Cardinal Orbit	1986	Goldsmith
Carefree Bright Pink	1968	Pan American
Carefree Coral	1973	Pan American
Carefree Crimson	1969	Pan American
Carefree Deep Salmon	1968	Pan American
Carefree Fickle Rose	1971	Pan American
Carefree Fickle Scarlet	1970	Pan American
Carefree Light Pink	1968	Pan American
Carefree Light Salmon	1968	Pan American
Carefree Picotee	1968	Pan American
Carefree Red	1968	Pan American
Carefree Rose	1973	Pan American
Carefree Scarlet	1968	Pan American
Carefree White	1968	Pan American
Century Orchid (Renamed Orchid Orbit '85)	1984	Goldsmith
Cherie	1976	Sluis & Groot/ Goldsmith
Cherie	1982	Sluis & Groot
Cherry Diamond	1984	Waltz

Cherry Glow	1980	Goldsmith
Cherry Orbit	1982	Goldsmith
Coral Orbit	1982	Goldsmith
Deep Rose Flash	1981	Pan American
Del Greco Series	1976	Farmen
Delta Queen	1982	Pan American
Encounter Red	1979	Ball
Encounter Salmon	1979	Ball
Firecracker	1977	Pan American
Fireflash	1978	Pan American
Flash Mix	1981	Pan American
Gala Amaretto	1983	Bodger
Gala Flamingo	1983	Bodger
Gala Redhead	1983	Bodger
Gala Sunbird	1983	Bodger
Gremlin Coral	1980	Harris
Gremlin Mix	1981	Harris
Gremlin Peach Blossom	1981	Harris
Gremlin Red	1981	Harris
Gremlin Rose Blossom	1981	Harris
Gremlin Rose-Pink/White	1981	Harris
Gremlin Strawberry Blossom	1984	Harris
Heidi	1979	Sluis & Groot
Hollywood Red	1984	Denholm
Hollywood Salmon	1984	Denholm
Hollywood Series	1983	Denholm
Hollywood Star	1984	Denholm
Hollywood White	1985	Denholm
Ice Queen	1980	Pan American
Innocence	1977	Harris
Jackpot	1980	Sluis & Groot
Knockout	1980	Goldsmith
Love Song	1977	Harris
Marathon Double Red	1980	Pan American
Marathon Double Rose	1983	Pan American
Marathon Double Scarlet	1982	Pan American
Matador	1977	Farmen
Merlin	1982	Goldsmith
Moreton Deep Salmon	1966	Harris
Moreton Red	1966	Harris
Moreton Scarlet	1966	Harris
Moreton Scarlet Picotee	1966	Harris
Moreton White	1966	Harris
Mustang	1979	Sluis & Groot
New Era	1969	Harris
New Era Bright Red	1969	Harris
New Era Light Salmon	1971	Harris
New Era Medium Salmon	1969	Harris
New Era Pastel Pink	1972	Harris
New Era Rose-pink w/White Eye	1973	Harris
Nittany Lion Red	1965	Ferry Morse
Orange Punch	1977	Farmen
Orbit Mix	1981	Goldsmith
Orchid Orbit	1985	Goldsmith
Picasso	1981	Sluis & Groot
Pink Orbit	1984	Goldsmith
Pinto Red	1985	Sluis & Groot
Pinto Rose	1985	Sluis & Groot
Pinto Salmon	1985	Sluis & Groot
Pinwheel	1982	Harris
Pinwheel Red	1985	Harris
Pinwheel Salmon	1982	Harris
Pinwheel Scarlet	1984	Harris
Playboy Mix	1981	Farmen
Playboy Salmon	1977	Farmen
Razzamatazz	1981	Ball
Red Champion	1977	Harris
Red Champion Improved	1979	Harris
Red Elite (Fleuro)	1982	Goldsmith
Red Express	1979	Pan American
Red Orbit	1981	Goldsmith
Red Pimpernel	1981	Sluis & Groot
Red Standard	1979	Harris
Ringleader Light Pink	1985	Vaughn
Ringleader Red	1985	Vaughn
Ringleader Salmon	1985	Vaughn
Ringo Deep Scarlet	1985	Sluis & Groot
Ringo Dolly	1982	Sluis & Groot
Ringo Light Salmon	1985	Sluis & Groot
Ringo Rouge	1979	Sluis & Groot
Ringo Salmon	1979	Sluis & Groot
Ringo Scarlet	1978	Sluis & Groot
Ringo White	1985	Sluis & Groot
Rose Diamond	1985	Waltz
Rosita	1978	Sluis & Groot
Rosita	1981	Sluis & Groot
Salmon Express	1980	Pan American
Salmon Flash	1978	Pan American
Salmon Orbit	1981	Goldsmith
Scarlet Diamond	1984	Waltz
Scarlet Flash	1977	Pan American
Scarlet Orbit	1981	Goldsmith
Scarlet Orbit Improved	1985	Goldsmith
Scarlet with an Eye Orbit	1986	Goldsmith
Showgirl	1977	Goldsmith
Sincerity (Renamed Friendship in 1979)	1977	Harris
Smash Hit	1980	Denholm
Smash Hit Red	1980	Denholm
Smash Hit Rose Pink	1982	Denholm
Smash Hit Salmon	1982	Denholm
Smash Hit White	1985	Denholm
Snowdon	1979	Sluis & Groot
Sooner Bright Pink	1979	Denholm
Sooner Deep Salmon	1977	Denholm
Sooner Red	1977	Denholm
Sprinter Deep Red	1976	Goldsmith
Sprinter Mixture	1977	Goldsmith

Sprinter Salmon	1976	Goldsmith
Sprinter Scarlet	1973	Sluis & Groot/ Goldsmith
Sprinter White	1976	Goldsmith
Steady Red	1984	Ball
Stella	1977	Farmen
Sundance	1985	Bodger
Sundance Orange Scarlet	1984	Bodger
Surefire	1981	Denholm
Tara	1982	Pan American
Tiffany	1980	Ferry Morse
Tiffany Red	1980	Ferry Morse
Video Series	1983	Bodger
White Orbit	1981	Goldsmith

III. Germination and Early Growth

A. Propagation

1. Geraniums are propagated by seeds or cuttings.
2. Seed geraniums represent about ½ of total geranium production in the U.S. and Canada.

B. Obtaining and Storing Seed

1. There are approximately 6,000 seeds per ounce.
2. Seed costs 2 to 5 cents each.
3. Use only hybrid seeds from reliable sources.
4. Procedure for keeping seeds viable:
   a. For best results, order new seeds each year.
   b. Store the seeds in a cool, dry place in insect- and rodent-free containers from year to year. Maintain relative humidity (in percent) and temperature (in degrees Fahrenheit) below 100.

C. Sowing Seed

1. Geranium seeds can germinate in any loose, sterile mix, such as one of the many peat-lite mixes available.
2. In seed flats, sow seed ⅜ inch deep, ¼ inch apart, with 1½ to 2 inches between rows.
3. In plugs, sow geraniums in the 208 or larger sizes. If sown in 400 to 600 size plugs, the seedlings must be transplanted within 3 to 4 weeks after germination to avoid a delay in flowering.
4. Cover with ⅛ inch layer of fine vermiculite, perlite or the sowing mix, for either seed flats or plugs.
5. To prevent damping off problems, drench the sowing mix with *Banrot*.
6. Seedlings are visible 72 hours under optimum conditions.

D. Watering

1. Sow seed in moist soil; do not let soil dry out.
2. For maximum germination, maintain uniform moisture throughout the germination period.
   a. Place flats under a mist system.
   b. Or, water the flat thoroughly and cover with glass or clear polyethylene so that germination can occur without additional watering.
3. Remove any covering at germination, usually between 5 and 10 days.
4. Water temperature should be warm; 70°F is ideal. Cooler water temperatures (below 60°F) will delay germination.
5. Germination will start in 3 to 4 days; most seeds will germinate by 14 days.

E. Temperature

1. Correct medium temperature is essential for quick germination and uniform germination rate.
2. Maintain medium at 70° to 75°F. Temperatures below 70°F can cause delayed and poor germination.
3. Medium temperature above 90°F will reduce germination rate.
4. Place a layer of clear polyethylene over the flats to keep humidity high and help maintain temperature (CAUTION: if polyethylene is used to cover flats, make certain temperatures DO NOT become excessive on sunny days.)
5. After germination occurs, and for up to six weeks after transplanting, night temperatures can be reduced to 62° to 65°F, and day temperatures should be maintained at 70° to 75°F. These temperature ranges promote good root formation.
6. Lower temperature to 60°F at night after six weeks; 70°F day temperature is still ideal.

F. Supplemental Irradiation

1. Supplemental irradiation promotes quicker germination and stronger seedlings.
2. Cool white fluorescent lamps placed 15 inches above the flats provide sufficient light for quick germination.
3. Keep the lamps on for 16 to 24 hours a day for the first 20 to 30 days after sowing.

G. Transplanting

1. Transplant from seed flats 14 to 21 days after sowing.
2. Transplant when first true leaves form. Do

not delay transplanting; the older the seedling, the more shock incurred at transplanting.

3. If seeds are sown in plugs, the seedlings may remain in the plugs for 4 to 6 weeks depending on plug size.
4. To hasten flowering, place plugs under high pressure sodium lights for 4 to 6 weeks at 350 to 400 foot candles for 18 to 24 hours per day. This will reduce the time-to-flower approximately one day for each day under the lights.
5. Transplant the seedlings to the base of the seed leaves so that the hypocotyl is deep enough to support the plant.
6. To prevent damping-off drench with one of the following: *Subdue* and *Terraclor, Subdue* and *Banrot, Subdue* and *Benlate,* or *Truban* and *Benlate.* CAUTION: DO NOT use *Banrot* if you drenched the flats with it.
7. One or two light applications of a 20-20-20 fertilizer at 100 ppm after germination but before transplanting may be needed. This depends on the soil nutrient level.
8. Thoroughly water the soil immediately after transplanting.

IV. Environmental Conditions for Pot and Flat Production

A. Media

1. Geraniums can be grown in soil or soilless media.
2. For rapid growth and root development, the medium must provide good aeration, drainage, nutrient-holding and moisture-holding capacity.
3. For most consistent results, use a peat-lite mix.
4. The ingredients for a typical bedding plant peat-lite mix are:
   a. 50 percent peat, 50 percent perlite; or 50 percent peat, 50 percent vermiculite by volume. (11 bushels peat, 11 bushels vermiculite/perlite per cubic yard*)
   b. 5 lb fine dolomitic lime
   c. 2 lb superphosphate 0-20-0
   d. 1 lb potassium nitrate
   e. 2 lb osmocote (14-14-14)
   f. 3 oz wetting agent

*One cubic yard = 27 cubic feet or 22 bushels. However, 15 to 20 percent shrinkage occurs in mixing, so for one full yard of mix add 4 bushels. Therefore, 26 bushels equal one yard.

B. Fertilization

1. Before fertilizing, determine the pH and soluble salt content of soil.
2. Use a pH meter and solubridge.
3. Constant feed program
   a. A regular feed program should begin 2 to 3 weeks after transplanting.
   b. To fertilize using a constant feed program, use 200 ppm of 20-10-20 fertilizer or 13.3 oz per 100 gal.
   c. The fertilizer program should be adjusted according to the growing mix and environmental conditions.
   d. Usual recommendation is 200 ppm each of nitrogen and potassium at every watering. Many growers use less and feed only enough to maintain good green color. Low levels of fertilizer keep plants short. Phosphorous is adequate from superphosphate plus phosphorous added with 20-10-20 fertilizer.
4. Slow-release fertilizer
   a. Slow-release fertilizer can be mixed in the growing medium.
   b. Osmocote 14-14-14 incorporated at 2 to 4 lb/cu yd works well.
5. Spot check pH and soluble salts weekly.
6. Send a sample of initial soil mix to the Michigan State University Soil Testing Lab for complete analysis. Make necessary adjustments to soil before planting.
7. Develop your own fertilizer schedule.
8. If you under-fertilize, plants will be short, yellowish in color and grow poorly.

C. Temperature

1. Seed germination requires a minimum constant temperature of 70° to 75°F.
2. Growing conditions are usually 62°F night and 70°F day temperatures.
3. Temperature is critical from time of visible bud until flower.
   a. The higher the temperature during this time, the shorter the time to flower, the smaller the flower head and the fewer the florets.
   b. At 80°F it may take only 12 days from visible bud to flower, while at 50°F it may take 45 days from visible bud to flower.
   c. 62°F produces the best flower size in a reasonable time to flower.
4. Day temperatures above 75°F after transplanting will result in taller plants.
5. It is estimated that every 10°F reduction from the 60°F night temperature will add a week to 10 days to the time to flower.

D. Light

Proper light is essential for good growth.

1. The geranium is very responsive to light intensity. It will flower in a shorter period of time under higher light intensities.
2. High intensity lights (high pressure sodium) at 350 to 400 foot candles for 18 to 24 hours per day for the first 4 to 6 weeks will reduce time to flower approximately 1 day for every day under light supplement in the mid-Michigan area.
3. Light is most effective in hastening time to flower in the early stages of growth.
4. Light has less of an effect after the plants are 6 weeks old.

E. Watering

1. Plants must have adequate water to grow normally.
2. Overwatering will result in increased disease problems; *Pythium* and *Rhizoctonia* may cause the abortion of the terminal shoot, which will result in increased lateral branching.
3. Underwatering will result in a yellow-brown discoloration of leaves followed by brown or necrotic spots.
4. Water early in the day so the foliage is dry by night.
5. Splashing water will spread bacterial stem rot if any seedlings are infected.
6. Adjust fertilization to accommodate the pH and soluble salt levels of the water supply.

V. Cultural Considerations for Pot and Flat Production

A. Scheduling

1. Assuming proper care, scheduling depends on variety, production system, container size and when the plants are to be sold.
2. Here is a suggested schedule for a 75-day crop:
   a. Day 1 (third week of February): sow in plugs or into final containers (75°F day and night).
   b. Day 7 High Intensity Discharged (HID) light (350 foot-candles): 24 hours per day for 5 weeks; 70°F after germination occurs.
   c. Day 35: first application of *Cycocel.*
   d. Day 42: second application of *Cycocel.* Remove from HID light and place under natural light, 72°F day temperature and 68°F night temperature.
   e. Day 75 (first week in May): Flower.

B. Spacing

1. The more space the plant has the bigger it will grow.
2. Most plants are grown in 18 cell flats or in 3½- to 4-inch pots. The pots are usually placed pot to pot.

C. Growth Retardants—

Growth retardants hasten flowering and help to keep plants compact.

1. Application of *Cycocel* at 1,500 ppm (1¾ fl oz/1 gal) will reduce final plant height and hasten flowering by 5 to 7 days. CAUTION: A foliar yellowing sometimes occurs at this concentration.
2. Spray *Cycocel* until it runs off. Add spreader sticker at 1 pt/100 gal or 1 tsp/1 gal.
3. Some growers use 750 ppm and make several applications.
4. Applications have to be made before flower initiation in order to be effective in hastening flowering.
5. Some growers make as many as 4 or 5 applications of 750 ppm *Cycocel.*
6. Remember that late applications will reduce flower size and may delay flowering.
7. *A-Rest* at 100 ppm as a foliar spray also works well but is more expensive than *Cycocel.*

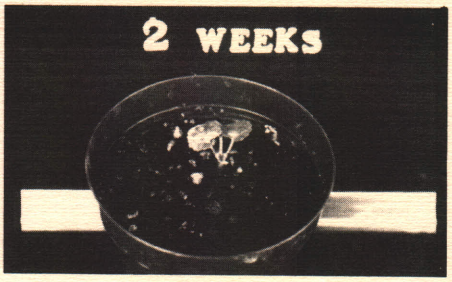
D. Preventing Petal Shattering

1. Flowers on most seed geranium varieties will shatter an average of 3 days after floret opening under normal conditions.
2. Higher temperatures will cause faster and greater shattering.
3. Cooler temperatures, such as 40°F, will reduce shattering.
4. Use silver thiosulphate (STS) to prevent shattering. Apply as soon as flower buds are visible.
5. Petals will remain on treated plants for 30 to 40 days.
6. Procedure for making silver thiosulphate.
   a. Dissolve 0.42 grams of silver nitrate ($AgNO_3$) in ½ liter of water.
   b. Dissolve 2.48 grams of sodium thiosulphate ($Na_2S_2O_25H_2O$) in ½ liter of water in a separate container.
   c. Add all of the silver nitrate solution to the sodium thiosulphate solution while stirring the mixture.
   d. Dilute the resulting STS solution by adding 9 liters of tap water to give a total

WEEKLY STAGES OF DEVELOPMENT OF GERANIUMS

(NATURAL LIGHT CONDITIONS)

WEEK 1



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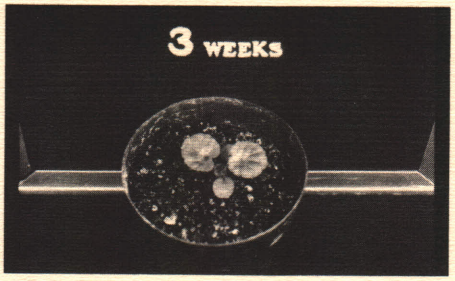

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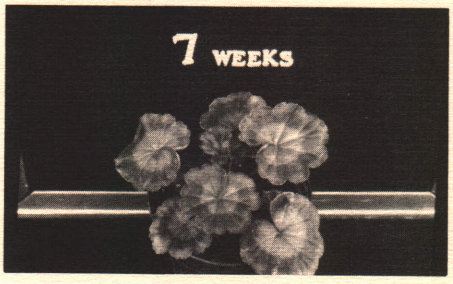

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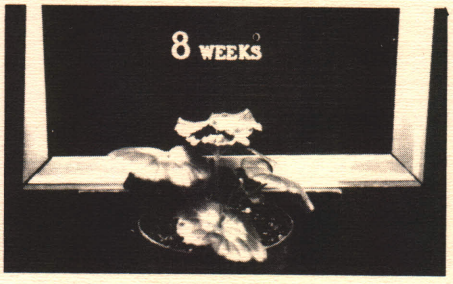

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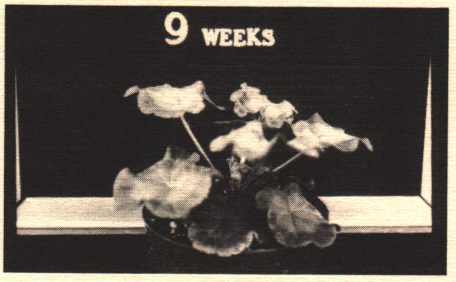

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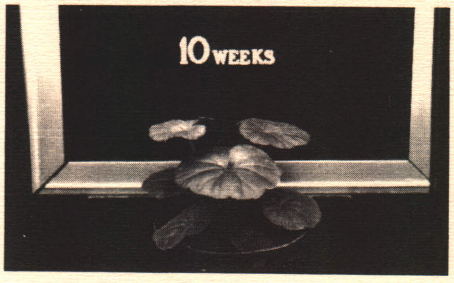

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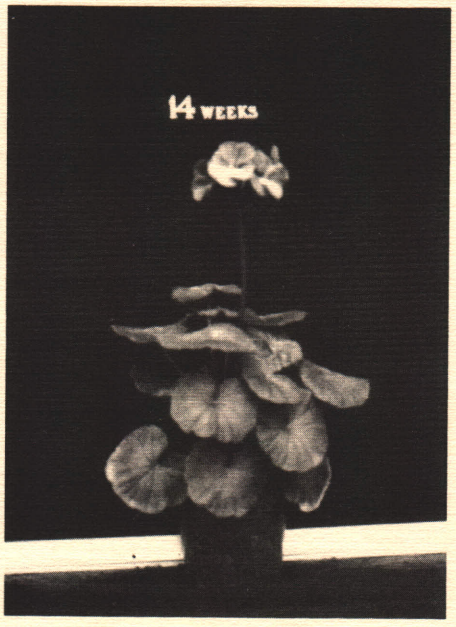
WEEK 11



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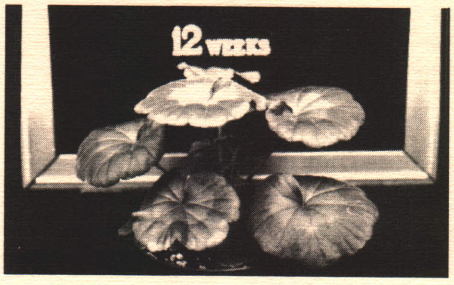
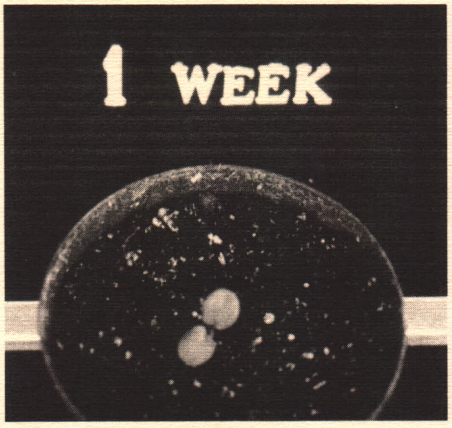


WEEK 12

WEEK 13

WEEKLY STAGES OF DEVELOPMENT OF GERANIUMS

(HIGH INTENSITY LIGHT CONDITIONS)



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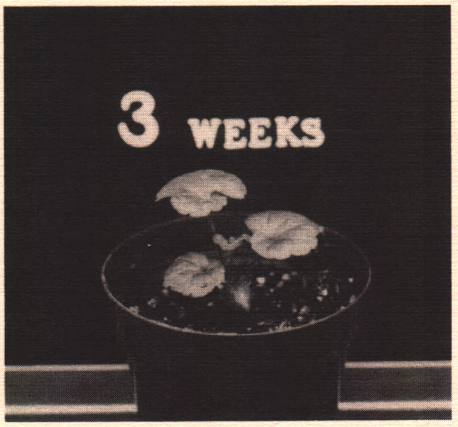

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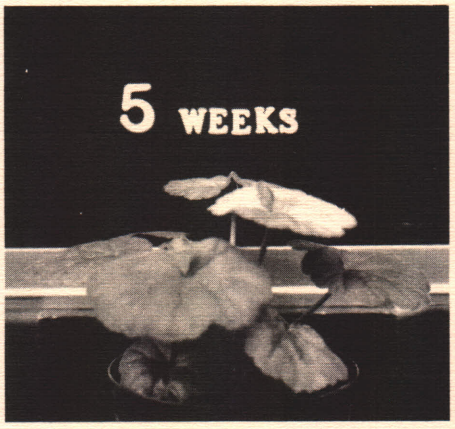

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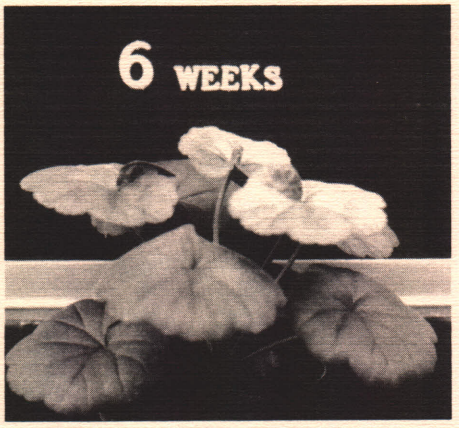

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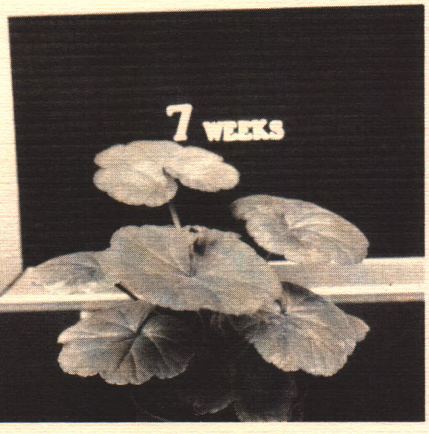

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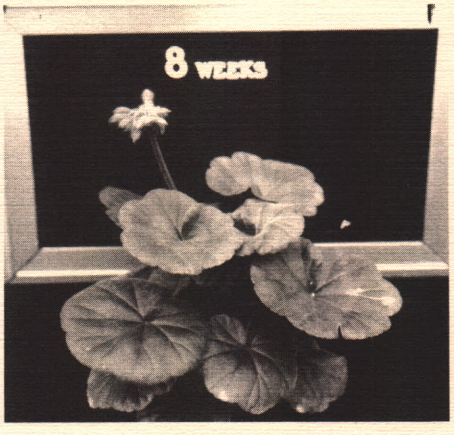

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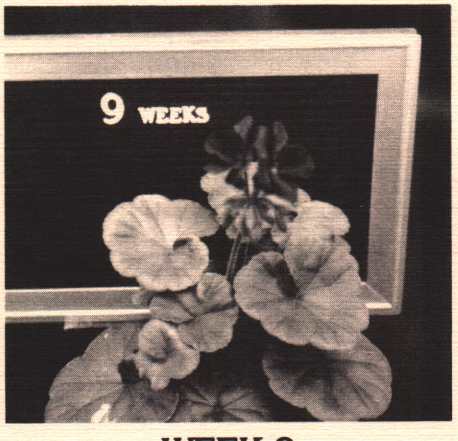

WEEK 9

volume of 10 liters. In most cases, tap water is acceptable. However, there may be unusual circumstances where compounds in the water can cause precipitation of the silver.

e. Spray plants with approximately 10 ml per plant. The 10 liters (2.6 gal) should cover 1,000 plants.

f. Plants should be treated any time after flower buds are visible, but before first florets open.

g. Use the dilute STS solution as soon as possible after mixing. If necessary, the STS solution can be stored safely in a refrigerator for up to one month. For longer storage periods, store the silver nitrate away from light or in a dark glass bottle.

h. Use glass or plastic containers. Metal sprayers may be used if the STS is sprayed immediately. Metal containers will deactivate the STS solution.

7. Caution: Make certain that plants are free from *Pythium* before applying STS. A *Subdue* application should be made before treating plants with STS. Plants that are infected with *Pythium* will die quickly when sprayed with STS.

VI. Problems

A. Diseases—There are four major diseases that affect geraniums.

1. *Botrytis* is a fungal disease and normally establishes itself on stressed, aging, dead, or inactive tissues. A beige-to-gray, fuzzy growth develops on diseased tissues. This growth is made up of the spore-producing structures and spores of *Botrytis* and gives rise to the common name gray mold.
   a. Cultural practices that can help reduce *Botrytis* disease include:
      1. Water in the morning only, so plant surfaces dry quickly and are not wet during cool, night periods.
      2. Space plants to allow good air circulation around and through them. This promotes rapid drying of plant tissues.
      3. In greenhouses, vent and heat in the evening to reduce humidity and prevent night-time dew formation.
      4. Keep plants and greenhouses clean. Remove and destroy dead flowers and leaves and overripe fruit. Prune dead and dying stems.
      5. Provide adequate fertilizer and water to keep plants vigorous. Avoid excessive nitrogen levels.
      6. Avoid injuring plant tissues.
   b. Several fungicides provide good control of *Botrytis*. When using chemical controls, read the chemical label for information on proper use.
      1. *Benlate*
      2. *Botran*
      3. Chlorothalonil (*Daconil* 2787)
      4. *Exotherm Termil*
      5. *Zyban*
2. Rust is caused by the fungus *Puccinia pelargonii zonalis*. Geranium rust occurs primarily on leaves, but occasionally on stems and petioles. Symptoms appear first on the lower leaf surface as small, circular, yellow spots that rapidly increase in diameter. Brown spore pustules develop in the center of the spots. Concentric rings of rust-brown spore pustules form within a few days.
   a. Cultural practices that can help reduce rust include:
      1. Avoid carrying over stock plants; or if you do, inspect them carefully for rust before purchasing and introducing new cuttings or taking cuttings from the old stock plants.
      2. Purchase only certified, culture-indexed cuttings; they may cost more initially but are less expensive over the life of the crop.
      3. Never take cuttings from field-grown plants because several cases of geranium rust have been traced to cuttings taken from cemeteries or home plantings.
      4. Avoid overhead watering.
   b. Several fungicides provide good control of rust diseases. When using chemical controls, read the chemical label for information on proper use.
      1. *Bayleton*
      2. Chlorothalonil (*Daconil 2787*)
3. *Rhizoctonia* is a fungal disease that attacks many species of plants. The fungus causes a seed rot, a pre-emergence damping-off or a post-emergence damping-off. Trouble may appear as poor seed germination—however, the seeds may have rotted in the soil. After the seedlings emerge, growth may be poor, and seedlings may wilt and topple over.

a. Cultural practices that help reduce *Rhizoctonia* include:
   1. Plant in light, well-drained, well-prepared soil or a pasteurized germination or growing medium.
   2. Avoid overcrowding, overwatering, deep planting and overfertilizing.
   3. Provide good air circulation and conditions that promote rapid seed germination.

b. Several chemicals provide good control of *Rhizoctonia.* When using chemical controls, read the chemical label for information on proper use.
   1. *Banrot*
   2. *Benomyl*
   3. *PCNB*

4. *Pythium* is a fungal disease that attacks many species of plants. *Pythium* causes root rot in young seedlings. A white mycelium grows between soil particles. *Pythium* grows best in moist conditions.
   a. Cultural practices that help reduce *Pythium* are the same as those listed for *Rhizoctonia.*
   b. Many chemicals provide effective control of *Pythium.* When using chemical controls, read the chemical label for information on proper use.
      1. *Banrot*
      2. *Captan*
      3. *Subdue*
      4. *Truban*

B. Insects and Mites

1. *Aphids* are soft bodied insects that vary in color and range in size from 2 to 5 mm. Adults may be winged or wingless, while nymphs always lack wings. All stages possess piercing-sucking mouthparts and a pair of cornicles located at the posterior end of the abdomen. Aphid feeding can cause severe leaf curl and other leaf distortions.
   a. Cultural practices to prevent aphids in your greenhouse include using strict sanitation, such as weed control, destruction of crop residue, and elimination of algae.
   b. There are several insecticides that may be used to control aphids. When using chemical controls, read the chemical label for information on proper use.
      1. *Dursban 50WP*
      2. *Malathion* 50 EC, 25 WP
      3. *Meta-Systox-R* 25 EC
      4. *Orthene* PT 1300
      5. *Temik* 10G
4. *Mealybugs* have elongate (3 to 5 mm), oval bodies covered with a white, mealy secretion. Numerous short, waxy spines are present along the body margin and at least two long wax filaments may be present at the posterior end. These sap feeders are usually found in leaf axils or along larger leaf veins. Mealybugs secrete large amounts of honeydew that cause a lush growth of black, sooty mold.
   a. Cultural practices to prevent mealybugs are the same as those for aphids.
   b. There are several insecticides that provide effective control of mealybugs. When using chemical controls, read the chemical label for information on proper use.
      1. *Dursban 50 WP*
      2. *Malathion WP*
      3. *Vapona*

3. *Spider Mite* adults are less than 1 mm in length, green-to-orange in color and have a characteristic pair of dark spots on their back. All stages suck fluid from plant cells, causing chlorosis or mottled yellowing of the foliage. Look for the presence of fine webbing as an indication of high mite numbers.
   a. Cultural practices to prevent spider mites are the same as those for aphids.
   b. There are several insecticides that provide effective control of spider mites. When using chemical controls, read the chemical label for information on proper use.
      1. *Dibrom*
      2. *Dursban* 50 WP
      3. *Kelthane*
      4. *Meta-systox R* 25 EC
      5. *Pentac*
      6. *Temik* 10 G
      7. *Vendex*
      8. *Vydate L*
4. *Whiteflies* are small, winged insects, 2 to 3 mm in length, characterized by the presence of a white powder on both pairs of wings. The adults are active flyers and can be dislodged easily from the infested leaves by a brush of the hand. Both adults and immatures suck plant sap and secrete large quantities of honeydew.
   a. Cultural practices to prevent whiteflies are the same as those listed for aphids.

b. There are several insecticides that provide effective control of whiteflies. When using chemical controls, read the chemical label for information on proper use.
   1. *Dursban 50 WP*
   2. *Meta-systox-R*
   3. *Resmethrin*
   4. *Temik 10 G*
   5. *Vapona*
   6. *Vydate L*

C. Physiological

1. High soluble salts cause root damage and iron chlorosis symptoms.
2. Overwatering causes terminal bud abortion in younger plants.
3. Flower bud abortion can be caused by low pH, moisture stress or ethylene damage.
4. Bronzing of foliage and necrotic spots can be caused by lack of water.
5. Reddish cotyledons, reddish lower leaves, and stunted growth can be caused by overwatering or cold temperatures.
6. Nitrogen deficiency causes lower leaves to become yellow, and an overall pale plant color.
7. Stunted plants and purplish leaf color can be caused by phosphorous deficiency or low temperatures (below 50°F).
8. High levels of iron in the rooting medium can lead to plant stunting and yellowing of lower leaves. Avoid liquid-feed programs with micronutrients if micronutrients are already incorporated in the medium.

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