SUCCESS WITH GARDEN MUMS

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Garden mums are a traditional fall crop and are fairly easy to grow. They also can be profitable. Below are some of the cultural guidelines to follow in growing garden mums.

Planting

Plant the cuttings immediately upon arrival. Planting depth is important. Do not plant them too deeply. The roots should barely be covered by the substrate. Water the plants in immediately with a complete N-P-K fertilizer solution at the rate of 200 to 250 ppm N. The plants may need to be misted or syringed 4 or 5 times a day during the first few days after potting. **Do Not** allow the plants to wilt or plant quality will be adversely affected: retardation of growth and the potential branching will be reduced.

If your cuttings have set a terminal bud, they will still produce a nice plant. Allow the plants to be established for 3 to 5 days prior to giving the plants a hard pinch.

If the cuttings can not be planted and must be held, they can be stored for several days in a cooler at 33 to 40 degrees F.

Containers

To help care for the new cuttings prior to their establishment, many growers plant cuttings into 36 to 72 unit cell packs (ie.: 1203's or 1204's). After 2 to 3 weeks of growth and the initial pinch has been given, the plants are transplanted into the final container.

The size of the final container used varies with the grower and their market. The most common pot size used is an 8" mum pan.

Spacing

Use 18" to 24" centers for an eight-inch pot, with less space required for later potted plants grown in smaller containers.

Table 1. Guidelines for foliar analysis values (based on dry weights) for mums.

Nutrient	Recommended concentration	Nutrient	Recommended concentration
N (%)	4.00-6.50	B (ppm)	25-100
P (%)	0.25-1.00	Cu (ppm)	5-50
K (%)	3.50-6.50	Fe (ppm)	50-300
Ca (%)	0.50-2.00	Mn (ppm)	30-350
Mg (%)	0.30-0.60	Zn (ppm)	15-50

Foliage of plants were sampled prior to or at flowering. Samples taken from the top-most, fully expanded leaves. Source: Plant Analysis Handbook of Georgia, 1988.

Varieties

Mums come in a wide assortment of colors and flower forms. Yellow is the most popular color of fall garden mums, representing 26% of the market (Yoder, 1996). Pink/lavender is the next most popular color (22%); followed by white, bronze, and red (14%, each); coral/salmon (6%), and orange (4%) account for the remainder. Yoder's top ten mum varieties are (listed in order): Bravo, Jessica, Debonair, Linda, Raquel, Nicole, Sundoro, Lisa, Anna, and Yellow Triumph. Match your cultivars with the colors popular in your market and the length of your marketing season.

Pinching

Pinch 7 to 14 days after potting rooted cuttings. Timing of the pinch varies with plant growth. Pinching should occur after the plants have become established and actively growing (ie.: 1 to 1°" of new top growth has developed and the roots are visible at the side of the tray pack). Remove around °"of growth when pinching. A second and third pinch may be required on the plants. Second and third pinches should be given after 3 to 4" of new growth has developed on the breaks, removing around 1/2" of growth. Generally in the Southeast, the last pinch date should be between July 10 and July 25. Pinching too late will delay flowering. An alternative to the second and third pinches is covered below under Florel use.

Florel as a Pinching Agent

The requirement of pinching garden mums for the second time is very labor intensive and costly. A relatively new production practice adopted by a number of growers is to replace the second pinch with an application of Florel. Research by Whipker (1996) compared the economics of Florel and a second pinch *(See the August 1996 NCCFG Bulletin, for this article).* The use of Florel resulted in labor savings of 3¢ per plant, or a $294 savings per 10,000 mums.

Florel is a liquid formulation of ethephon (ethylene) and acts as a plant growth regulator by: 1. stimulating lateral branching, 2. controlling stem elongation, and 3. encouraging vegetative growth while controlling flowering. A rate of 500 ppm is commonly used as a substitute for the second pinch, which is roughly 30 to 40 days after potting. Research at North Carolina State University by Larson and McCall (1995) found that a single application of Florel at 500 ppm produced good quality plants that were comparable to plants manually pinched a second time. Florel treated plants had a slight delay in the appearance of buds compared to the manually pinched plants, but the difference was not noticeable at the conclusion of the experi-

ment. Florel causes flower bud abortion and the final application should be at least 6 to 7 weeks prior to the scheduled flowering date to avoid delay of flowering. Florel also works as a plant growth regulator by controlling plant height. Adjust your use of plant growth regulators like B-Nine as needed.

Some growers apply multiple applications of Florel to delay flowering, hence spreading out their marketing season for garden mums. Discuss this option with your plant broker to determine a production schedule that is suitable for your operation.

Plant Growth Regulators

Plant growth varies with the cultivars and some can get too tall and require the application of a plant growth regulator. Growers will require at least a minimal amount of growth regulator. A plant growth regulator should be applied after the final pinch, when 1°" to 2°" of new growth has occurred. This will reduce plant height, intensify the dark green color of the foliage, and most importantly create round, more uniform plants. Yoder recommends foliar sprays of B-Nine at 2500 ppm, starting around 2 weeks after the last pinch. Additional applications at the same rate can be used if the plants begin to stretch. Do not apply after buds are visible or a reduction in flower diameter is possible.

Sumagic is a very active chemical. Growers need to experiment with a small amount of their crop to test the effectiveness and determine optimal rates. Cultivar response will vary. The label rate for Sumagic is 2.5 to 10 ppm, with lower rates suggested for cool growing climates. Start with the lower range of suggested rates.

Whether using B-Nine or Sumagic, remember to reduce the rate of plant growth regulators if you are applying Florel.

Fertilization and Irrigation

Maintain root medium pH between 5.8 to 6.2 for soilless substrates and 6.0 to 6.5 for soil based substrates. Use a complete N-P-K fertilizer like 15-5-15 Cal-Mag or 20-10-20 (with supplemental calcium and magnesium being applied) at the rate of 200 to 250 ppm N via irrigation water. Use a fertilizer that provides 60 to 75% of the nitrogen in the nitrate (NO_3-N) form. Slightly lower fertilization rates may be sufficient for a soil based substrate, while slightly higher rates are suggested for a bark-based mix. Growers need to manage their fertility program to avoid excessive EC buildup or leach salts every month. Research by Larson and McCall (1995) at North Carolina State University found that higher fertilization rates of 500 ppm N did not provide any additional benefit when compared to 300 ppm N.

Low fertilization rates results in small plants. Fertilization may need to be supplemented with a higher rate or a slow release fertilizer like Osmocote (14-14-14) if excessive leaching occurs due to heavy rains. Fertilization should be decreased or terminated when the flowers begin to open to improve flowering longevity. Foliar analysis values for garden mums are provided in Table 1 and a key to nutrient deficiency symptoms are listed in Table 2.

Drought stress can cause yellowing of the lower leaves. In the middle of the summer, the water demand of mums may require multiple irrigations per day. This may make hand watering impractical. Automatic drip irrigation systems are commonly used. The drip system should be designed so the plants are placed at their final spacing. Avoid overhead sprinklers due to the potential of promoting foliar diseases and the difficulty in targeting water into the pot late in the season after the plant canopy covers the pot.

Inducing Flowers

Garden mums are photoperiodic plants. Which means the length of day (or more correctly, length of darkness) influences the flowering pattern of the plant. The critical night length to cause garden be mums to initiate flowers is between 9.5 to 10.5 hours (Pertuit, 1996). Most cultivars on the market will naturally flower during September 10 to October 10. Consult your cutting supplier for establishing a schedule that meets your market demands.

Growers can also extend their marketing season by shading plants to induce earlier flowering. A shading system utilizing black cloth or black plastic is used during the approximately seven weeks required to induce flowering. The shading system is pulled over the plants at dusk to limit heat buildup under the cloth and removed early in the morning. This provides at least 11 to 12 hours of darkness. High average temperatures can cause heat delay, with flowering potentially being delayed 1 to 3 weeks. The shade cloth is not used on evenings when heavy rainfall is expected due to water pooling on the cloth. A sample schedule for shading plants is given in Table 3.

Cost of Production

Profitable production of garden mums is dependent upon the knowledge and control of production costs. A grower who understands production costs will be better prepared to make decisions on the optimal number of plants to produce and to help establish prices. Readers interested in costs should refer to their August 1996 NC Commercial Flower Growers' Bulletin for production costs of garden mums.

Diseases

The primary diseases of garden mums are bacterial leaf spot, septoria leaf spot, pythium, and botrytis. Bacterial

Table 2. Symptoms of nutrient deficiencies in chrysanthemums.

Element	Deficiency Symptoms
Nitrogen (N)	1. Reduction in plant vigor and small, light green to yellowish foliage.
	2. In severe cases, lower leaves are chlorotic and have reddish veins and margins.
	3. Growth and flower size is reduced and flowering date is delayed.
Phosphorus (P)	1. Lower leaves turn reddish to yellow to brown beginning at the leaf apex.
	2. Leaf size of newly developed leaves is reduced and lower stem portions may develop a deep purple color.
Potassium (K)	1. Lack of plant vigor, small leaves and weak stems with first appearance on lower leaves.
	2. In severe cases, leaves develop interveinal and marginal chlorosis followed by necrosis.
Calcium (Ca)	1. Small, curled, thickened leaves around growing point.
	2. In severe cases, death of growing point and rosetting of leaves.
	3. Peduncles break over about time flower color shows and flowers have poor keeping quality.
	4. Stubby and brown roots.
Magnesium (Mg)	1. Appears first as interveinal chlorosis and curling under of older leaves. Veins remain green.
	2. Severe cases have reddish colored spots interveinally and along leaf margins, gradually moving to upper leaves.
Boron (B)	1. Red pigment in veins with interveinal chlorosis.
	2. Corky veins and sides of petioles with brittle, downward-cupped leaves.
	3. Terminal bud may die or secondary flower buds fail to develop normally. Larger flowers do not open fully and are more incurved than normal.
	4. Roots brown and stubby.
Copper (Cu)	1. Dull green leaves, chlorotic veins. Veinal chlorosis produces inverse "netting." Margins remain green.
	2. Affected leaves wilt during day, outer margins turning upward.
	3. Flowers are small, reflex, and soft.
Iron (Fe)	1. Interveinal chlorosis of young leaves becoming a general chlorosis in leaves severely affected. A common deficiency when root substrate pH is high.
Manganese (Mn)	1. Generally pale green plants with mild interveinal chlorosis of young leaves not as distinctly outlined as in iron deficiency.
	2. Severe cases with small necrotic spots in middle leaves, affecting up to 1/4 of the surface. Interveinal, first white or grey, then tan.
Zinc (Zn)	1. A rarely seen deficiency. Appears as plant approaches blooming stage. Small chlorotic spots at any position on middle or upper leaves.
	2. Chlorotic spots gradually develop necrotic spots in the center.

Source: Raulston, J.C., W.E. Waters, S.S. Woltz, and C.M. Geraldson, 1972. Summary of chrysanthemum fertilization programs for field production in Florida. Florida Flower Grower, 9(10), p9.

Table 3. Early shaded garden mum timetable - 1997. (6" or 6-1/2" pots - cuttine per pot)

Plant	Approx. first pinch	Approx. second pinch	Shade	Flower 7 weeks later
Apr. 28	May 12	June 02	June 02	July 21
May 05	May 19	June 09	June 09	July 28
May 12	May 26	June 16	June 16	Aug. 04
May 19	June 02	June 23	June 23	Aug. 11
May 26	June 09	June 30	June 30	Aug. 18
June 02	June 16	July 07	July 07	Aug. 25
June 09	June 23	July 14	July 14	Sept. 01

Based on starting with a rooted cutting. Long days provided until the shade date. Source: Yoder's 1996-1997 Garden Mums Guide.

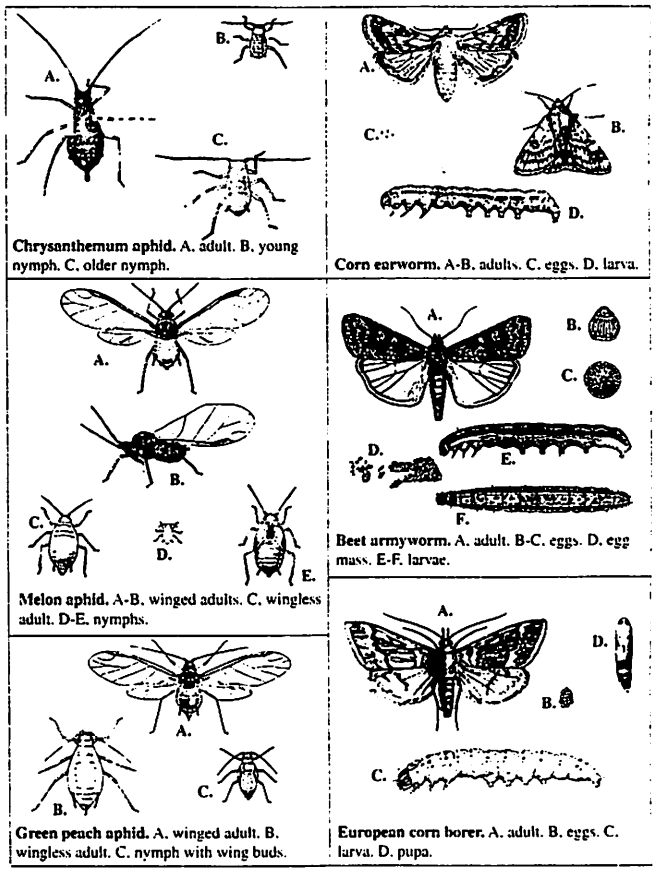

Figure 1. Common Garden Mum Insect Pests. Source: J.R. Baker (ed.). 1994. Insect and related pests of flowers and foliage plants. N.C. Cooperative Extension Service Bulletin AG-136. 106 pp.

leaf spot is caused by *Pseudomonas cichorii* which is often more prevalent following periods of heavy summer rains. Bacterial leaf spot development is favored by moisture, high humidity, high temperatures, and/or use of susceptible cultivars. Bacterial leaf spot development symptoms include dark-brown to black spots that can cover half the leaf. These spots eventually expand to irregularly shaped lesions. The disease typically begins at the lower leaves and will spread upward, usually on one side of the plant. Rogue infected plants and apply Kocide 101 77WP (copper hydroxide) or Bordo-Mix 12.75WP to susceptible cultivars.

Septoria leaf spot is caused by *Septoria chrysanthemella* and symptoms include small yellow spots that later turn dark brown to black. Later, leaves may turn yellow and drop from the plant or may remain attached to the stems. The disease is spread by splashing water, so overhead watering should be avoided. Daconil 278775WP, Captan, Kocide 101 77WP, Cleary's 3336, Domain, or Systec 1998 4F are labeled for septoria leaf spot.

Pythium is usually present in most media. Growers should avoid growing conditions which stress the plant, such as continuously waterlogged medium, cool medium temperatures, or cool air temperatures. If needed, monthly drenches of Subdue, Aliette, or Banrot can be applied.

Botrytis can also be a problem on leaves and flowers. Avoid overhead watering and space plants far enough apart to allow for good air circulation.

Insects and Mites

Garden mums are less susceptible to insect and mite pests compared to florist mums. However, garden mums can be attacked by a number of insect/mite pests such as aphids, leaf miners, spider-mites, thrips, and caterpillars, (Figure 1). Mosts pests can be managed with a proper scouting program. Early pest detection can lead to fewer problems, especially when pest populations are low compared to trying to control high pest populations or populations that are rapidly building-up. In addition, early pest detection can maximize the effectiveness of foliar-applied and/or systemic pesticides.

Aphids. Green peach aphid, melon aphid, and chrysanthemum aphid are the common species that feed on garden mums. Aphids feed on terminal growth, flower buds prior to opening and on leaves in the plant interior when plants are bushy. They feed on plant tissue with their piercing/sucking mouthparts causing plant stunting, wilting, leaf yellowing, and leaf curling. A by-product of their feeding is a clear, sticky honeydew substance that coats plant leaves. Honeydew serves as a medium for black sooty mold fungus. The presence of black sooty mold fungus and/or aphid cast-skins can reduce crop marketability. Aphids are soft-bodied insects that have tubes (cornicles) located on their abdomens. Females can give birth to 60 to 100 live young per day for a period of 20 to 30 days. This ability to reproduce quickly leads to tremendous numbers within a short period of time. Aphids feeding on exposed terminals or flower buds allow for better control with contact insecticides. However, aphids feeding within the plant canopy are harder to control with contact insecticides, because it is difficult to get thorough coverage. Aphids that attack garden mums when placed outside are exposed to many natural enemies which may provide some control. For example, female parasitic wasps will lay eggs inside aphids and eventually turn aphids into gray-brown mummies.

Chemicals used for aphid control include acephate (Orthene), imidacloprid (Marathon), bifenthrin (Talstar), fenpropathrin (Tame), endosulfan (Thiodan), azadirachtin (Azatin), chlorpyrifos (Duraguard), horticultural oil (UltraFine Sun Spray), insecticidal soap (M-Pede), methiocarb (Mesurol), and diazinon (Knox-Out).

Leaf miners. Leaf miners can cause considerable damage to garden mums if not detected early. Chrysanthemum and serpentine leaf miners are the common species that infest garden mums. Adult females puncture the leaf surface and lay eggs inside the leaf with their ovipositor. Eggs hatch into larvae that tunnel between the upper and lower leaf surfaces creating white blotches and/or twisting mines. These mines can disfigure leaves and reduce crop marketability. Chemicals used for leaf miner larvae are abamectin (Avid), acephate (Orthene), cyromazine (Citation), and azadirachtin (Azatin, Neemazad). Chemicals used for adult control are chlorpyrifos (Duraguard) and permethrin (Astro).

Spider mites. Two-spotted spider-mite is the common species that can infest garden mums. Spider-mites feed primarily on leaf undersides removing plant sap (chlorophyll) with their styletlike mouthparts. Their feeding causes leaves to have a "stippled" appearance which appears on the leaf upper side. Severe mite damage can cause leaf drop. Two-spotted spider-mites are yellow-brown to dark green in color with two dark spots on both sides of the body. Mites are a problem under dry and warm (70 degree F) weather conditions. Development from egg to adult can occur within 14 to 21 days depending on temperature. The higher the temperature the less time it takes to go from egg to adult.

Chemicals used for control of spider-mites are abamectin (Avid), dienochlor (Pentac), dicofol (Kelthane), pyridaben (Sanmite), fenpropathrin (Tame), bifenthrin (Talstar), and horticultural oil (Ultra-Fine Sun Spray).

Thrips. Western flower thrips and flower thrips are the two most common species that attack garden mums. Thrips feed on leaves and flowers with their rasping-piercing-sucking mouthparts. They cause leaves to have a silvery appearance and they leave black fecal droppings. Thrips can also damage flowers by scarring the petals, deforming flower buds, and causing bud abortion. Thrips are generally a problem when the crop is in the greenhouse. Thrips are small insects approximately 1 to 2 mm long. Females lay eggs into leaves or flower petals. When young emerge from eggs they feed on leaves and flower buds. Thrips pupate in soil, leaf litter, and even on plants. After pupation, they emerge as winged adults. Once thrips enter unopened flower buds they are extremely difficult to kill with contact insecticides.

Chemicals used for thrips control include abamectin (Avid), acephate (Orthene), fenpropathrin (Tame),

chlorpyrifos (Duraguard), *Beauveria bassiana* (Naturalis-O/Botaniguard), diazinon (Knox-Out), and azadirachtin (Azatin, Neemazad).

Caterpillars. Beet armyworm, cabbage looper, fall armyworm, corn earworm, and European corn borer can infest garden mums. Caterpillars can infest almost all above ground portions of plants. They feed on leaves, stems, and flower/terminal buds. Adult females (moths) lay eggs on plant parts. Young larvae emerge from eggs and begin feeding. Caterpillars consume more as they mature until they reach the stage where they are ready to pupate and then turn into adults. Adults generally migrate onto garden mums when the plants are placed outside. Chemicals used for caterpillar control include *Bacillus thuringiensis* (Dipel), acephate (Orthene), fluvalinate (Mavrik), permethrin (Astro), bifenthrin (Talstar), and cyfluthrin (Decathlon).

References

Larson, R.A. and I.F. McCall. 1995. Garden chrysanthemum culture the easy way. N.C.

Flower Growers' Bull. 40(6):I-3. Pertuit, A.J. Jr. 1996. Garden mums. Georgia Floriculture 6(4):14-18.

Pundt, L. 1995. Watch for these pests of garden mums. Connecticut Greenhouse Newsletter, No. 185, Apr./May 1995.

Whipker, B.E. 1996. Cost of producing containerized garden mums: 1996. N.C. Flower Growers' Bull.41(4):I-6.

Yoder Garden Mum Cultural Manual, 1996-1997.

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