GUIDE TO SUCCESSFUL OUTDOOR GARDEN MUM PRODUCTION

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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.

Keys to Success with Garden Mums

1. Inspect and plant cuttings upon arrival.
2. Provide sufficient water.
3. Manage your fertility program.
4. Use a well-drained medium.
5. Space plants for proper growth and good air circulation.
6. Select proper cultivars.
7. Calculate your production cost.

Planting

Inspect and plant the cuttings immediately upon arrival. Planting depth is very important. Do not plant them too deeply. The roots should be barely covered by the medium. 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, i.e., 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 become established for 3 to 5 days and then give them 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 °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.: 1203s or 1204s). After 2 to 3 weeks of growth and the initial pinch has been done, the plants are transplanted into the final container. Typically, one plant is placed in each container. The size of the final container used varies with the grower and their market. The most common pot size used is an 8-inch mum pan.

Spacing

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

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%). Yoder's top 10 mum varieties are (listed in order): Bravo, Jessica, Debonair, Linda, Raquel, Nicole, Sundoro, Lisa, Anna, and Yellow

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Triumph. Match your cultivars with the colors popular in your market and the length of your marketing season.

Pinching

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

Florel as a Pinching Agent

The requirement of pinching garden mums for the second and third times is very labor intensive and costly. A relatively new production practice adopted by a number of growers is to replace these subsequent pinches with an application of Florel. Research by Whipker (1996) compared the economics of Florel and a second pinch (Table 1). The use of Florel resulted in labor savings of almost 3¢ per plant, or a $294 savings per 10,000 mums.

Florel is a liquid formulation of ethephon (an ethylene producer) and acts as a plant growth regulator by:

- Stimulating lateral branching
- Controlling stem elongation
- Encouraging vegetative growth while controlling flowering.

A rate of 500 ppm is commonly used as a substitute for the second pinch, which occurs 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

Table 1. Comparing the production cost of replacing the second pinch of garden mums with an application of Florel.

		Florel		2nd Pinch
		Cost Per Pot		
Labor and Chemicals				
Pinch #1		$0.0028		$0.0028
Pinching Option				
Pinch #2				$0.0306
B-Nine		$0.0070		$0.0120
B-Nine Application Labor		$0.0040		$0.0040
Florel Option				
Florel		$0.0022		
Florel Application Labor		$0.0040		
	TOTAL Difference	$0.0200	$0.0294	$0.0494
Total Savings with Large Number of Pots Produced	30,000 Mums 50,000 Mums 70,000 Mums		$882 $1,470 $2,058	

experiment. *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 and produce a larger plant, 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 1/2 inches to 2 1/2 inches of new growth has occurred. This will reduce plant height, intensify the dark green color of the foliage, and *most importantly create rounder, 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 plant growth regulator rate if you are applying Florel.

Fertilization and Irrigation

Maintain root medium pH between 5.8 to 6.2 for soilless media and 6.0 to 6.5 for soil based media. Use a complete N-P-K fertilizer such as Excel® 15-5-15 Cal-Mag or 20-10-20 (with supplemental calcium, magnesium, and mirconutrients being applied) at the rate of 200 to 250 ppm N and K applied in the 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 medium, while slightly higher rates are suggested for a bark-based mix. Growers need to manage their fertility program to avoid excessive electrical conductivity (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.

Table 2. Guidelines for foliar analysis values (based on dry weights) for mums.

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

Foliage of plants was sampled prior to or at flowering. Samples taken from the top-most, fully expandedleaves and are only guidelines.

Source: *Plant Analysis Handbook for Georgia*, 1988.

Table 3. Element deficiency symptoms.

Nitrogen (N)	Reduction in plant vigor and small, light green to yellowish foliage. In severe cases, lower leaves are chlorotic and have reddish veins and margins. Growth and flower size are reduced and flowering date is delayed.
Phosphorus (P)	Lower leaves turn reddish to yellow to brown beginning at the leaf apex. Leaf size of newly developed leaves is reduced and lower stem portions may develop a deep purple color.
Potassium (K)	Lack of plant vigor, small leaves and weak stems with first appearance on lower leaves.

(continued on the next page)

Table 3. Element deficiency symptoms. *(continued)*

Potassium (K) *continued*	In severe cases, leaves develop interveinal and marginal chlorosis followed by necrosis.
Calcium (Ca)	Small, curled, thickened leaves around growing point. In severe cases, death of growing point and rosetting of leaves. Peduncles break over about time flower color shows and flowers have poor keeping quality. Stubby and brown roots.
Magnesium (Mg)	Appears first as interveinal chlorosis and curling under of older leaves. Veins remain green. Severe cases have reddish colored spots interveinally and along leaf margins, gradually moving to upper leaves.
Boron (B)	Red pigment in veins with interveinal chlorosis. Corky veins and sides of petioles with brittle, downward-cupped leaves. Terminal bud may die or secondary flower buds fail to develop normally. Larger flowers do not open fully and are more incurved than normal. Roots brown and stubby.
Copper (Cu)	Dull green leaves, chlorotic veins. Veinal chlorosis produces inverse "netting." Margins remain green. Affected leaves wilt during day, outer margins turning upward. Flowers are small, reflex, and soft.
Iron (Fe)	Interveinal chlorosis of young leaves becoming a general chlorosis in leaves severely affected. A common deficiency at high root medium pHs.
Manganese (Mn)	Generally pale green plants with mild interveinal chlorosis of young leaves not as distinctly outlined as in iron deficiency. Severe cases with small necrotic spots in middle leaves, affecting up to 1/4 of the surface. Interveinal, first white or gray, then tan.
Zinc (Z)	A rarely seen deficiency. Appears as plant approaches blooming stage. Small chloritic spots at any position on middle or upper leaves. 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), p. 9.

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 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 4.

Scheduling/Timing

An example schedule is given for producing a natural season garden mum, Table 5. This is a basis for planning your schedule, but variations will occur due to variety selection, environmental conditions, and fertility programs. Consult your cutting supplier for setting up a customized schedule for your operation.

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. The costs presented here should be useful to current growers who wish to compare their own production expenses and for potential growers in determining whether to begin growing garden mums. The data was collected from a Midwestern grower who produced 70,000 garden mums. Costs are calculated for the 1996 growing year, Table 6.

Costs: variable versus fixed. Costs can be categorized as either variable or fixed. Variable costs, also called

Table 4. Early shaded garden mum timetable - 1997 (6" or 6-½" pots - one cutting per pot).

Plant	Approximate First Pinch	Approximate Second Pinch	Shade	Flower 7 Weeks
Apr. 28	May 12	June 02	June 02	July 21
May 05	May 9	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	Sep. 01

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

Table 5. Example production schedule for natural season garden mums.

Date	Second Pinch Schedule	Florel Schedule
May 20	Pot	Pot
June 3	Pinch 1	Pinch 1
June 17	Pinch 2	Florel Application[2]
July 1	B-Nine Application[1]	
July 15	B-Nine Application[3]	B-Nine Application
July 29	B-Nine Application[3]	
Mid-September to mid-October	Flowering[4]	Flowering[4]

[1] B-Nine applied after the last pinch when 1½ to 2½ inches of the growth has occurred.Additiona application used only if needed.
[2] Florel applied as a substitute for a second pinch at 500 ppm.
[3] B-Nine application only required if excessive growth has occurred.
[4] Cultivar dependent.

direct costs, are costs that are incurred directly by growing the crop. Variable costs items are the basic inputs required to grow a crop, such as pots, plants, media, or chemicals. These items' costs are fairly easy to allocate to a specific crop because you know the materials used to produce the crop and production practices you followed. The direct costs are $0.98 per pot.

Fixed costs, also called overhead or indirect costs, are incurred whether or not a crop is produced. They include items like management salaries, depreciation, insurance, interest, repairs, and taxes. Fixed costs represent general operation expenses present in every greenhouse facility. To get a good measure of profitability, these costs need to be allocated to each crop grown. In general, for greenhouse operations, fixed costs are allocated to a crop on a cost-per-ft2 -per-week basis. Because garden mums are grown outdoors, fixed costs were allocated to the mum crop on a percentage basis, based on: the actual use of a piece of equipment or as a percentage of sales. The remaining percentage not allocated to the mum crop would then be allocated to the other crops produced like bedding plants or poinsettias.

Fixed costs are only $0.05 per pot.The fairly low depreciation expense can be attributed to this firm's reliance on used equipment. Firms which purchase new machinery and equipment will have a higher depreciation expense.

Shrink. Even under the best production practices, a certain percentage of the crop will not be marketable due to poor growth, insects, disease, or damage. The cost of inputs for these non-marketable plants have to be accounted for by the operation. This is done by adjusting the production cost by a shrink factor. In this case, a 3% shrink was calculated which involved dividing the total production costs by 0.97 to get the total production costs (including shrink). Total production costs will increase for growers who have a higher percent of shrink.

Total production costs per pot , including a 3% shrink and costs for marketing the crop was $2.07.

Profitability. By adding the total variable costs and total fixed costs together, this provides the total costs of producing a crop. The profitability of the crop is directly related to the price received. The profitability per pot of a delivered garden mum was $0.627 (a 23% profit margin).

Using the method outline in this handout will enable mum growers the ability to compare the profitability of their crops for their own operation. Of course costs will vary among greenhouses according to their amount of capitalization in equipment and structures and their ability to purchase inputs at lower costs. Therefore, each operation will need to calculate their specific production costs in order to determine their own profitability.

Table 6. Example production costs for natural season garden mums.

Item	Cost per Pot
Direct Items	
Cutting	$0.2000
Pot/Soil	$0.2410
Fertilizer	$0.0200
Chemicals	$0.1746
Sub-Total	**$0.635**
Labor	$0.3007
Sub-Total Indirect Costs	**$0.936**
Interest on Direct Expenses (Direct expenses * 9% interest * 0.5 years)	$0.0421
Total Direct Costs	**$0.936**
Indirect Costs	
Equipment/Interest/Repairs	**$0.228**
Overhead Operation Costs	$0.2263
Full-time labor	$0.2868
Utilities/Taxes/Misc. Costs	**$0.513**
Sub-Total	
Total Indirect Costs	**$0.741**
Total Production Costs	$1.720
3% Loss (divide T.P.C. by 0.97)	$0.0532
Total Costs (including shrink)	$1.773
Delivery Cost (Labor and Expenses)	$0.30
Total Costs (Delivered)	**$2.073**
Revenue	
Wholesale Price: Non-delivered and Delivered	$2.70
Total Net Profit per Pot (Wholesale)	
Non-Delivered	$0.927
Delivered	$0.627

Diseases

The primary diseases of garden mums are bacterial leaf spot, Septoria leaf spot, Pythium, and Botrytis. Bacterial 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 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 Bordo-Mix 12.75WP or Kocide 101 77WP (copper hydroxide) to susceptible cultivars.

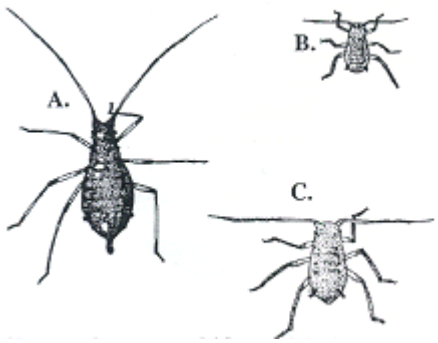
Septoria leaf spot is caused by *Septoria chrysanthemella*, and symptoms include small yellow spots that later turn dark brown to black. Later, leaves may turn yellow and drop from the plant or may remain attached to the stems. The disease is spread by splashing water, so overhead watering should be avoided. Cleary's 3336, Daconil 2787

75WP, Domain, Kocide 101 77WP, or Systec 1998 4F are labeled for Septoria leaf spot.

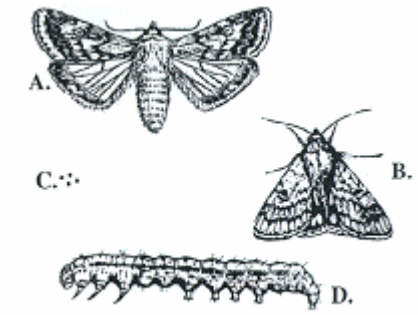
Pythium is usually present in most media. Growers should avoid growing conditions which stress the plant, such as continuously water-logged medium, high EC levels, cool medium temperatures, or cool air temperatures. If needed, monthly drenches of Aliette, Banrot, or Subdue Maxx can be applied.

Botrytis can also be a problem on leaves and flowers. Avoid overhead watering and space plants to allow for good air circulation. Fungicides registered for control of Botrytis on chrysanthemums are fludioxinil (Medallion), iprodione (Chipco 26019), mancozeb (Protect T/O), and vinclozolin (Ornalin).

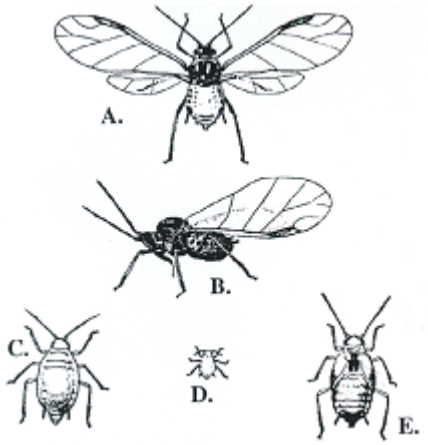
Figure 1. Common garden mum insect pests.



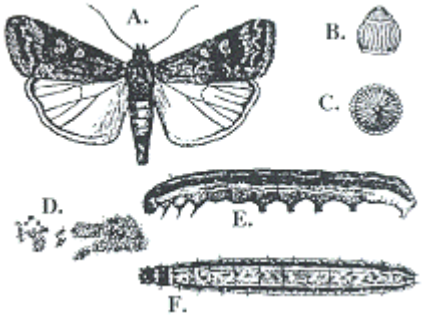
Chrysanthemum aphid. A adult, B young nymph, C older nymph.



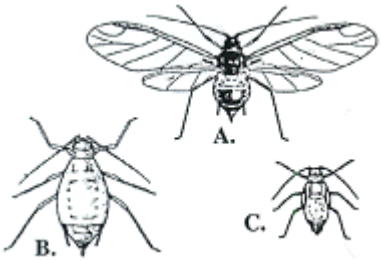
Corn earworm. A-B adults, C eggs, D larva



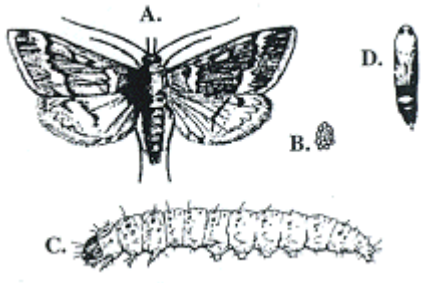
Melon aphid. A-B winged adults, C wingless adult, D-E nymphs.



Beet armyworm. A adult, B-C eggs, D egg mass, E-F larvae.



Green peach aphid. A winged adult, B wingless adult, C nymph with wing buds.



European corn borer. A adult, B eggs, C larva, D pupa.

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.

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, caterpillars, leaf miners, spider mites, and thrips, Figure 1. Most 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 controlling 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. Chrysanthemum aphid, green peach aphid, and melon 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. When garden mums are placed outside, aphids 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), azadirachtin (Azatin), bifenthrin (Talstar), chlorpyrifos (Duraguard), diazinon (Knox-Out), endosulfan (Thiodan), fenpropathrin (Tame), horticultural oil (Ultra-Fine Sun Spray), imidacloprid (Marathon), insecticidal soap (M-Pede), and methiocarb (Mesurol).

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 control are abamectin (Avid), acephate (Orthene), azadirachtin (Azatin), and cyromazine (Citation). 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 stylet-like 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 ^{o}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), bifenthrin (Talstar), dicofol (Kelthane), fenpropathrin (Tame), horticultural oil (Ultra-Fine Sun Spray), and pyridaben (Sanmite).

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 (1/8 inch) 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), azadirachtin (Azatin), Beauveria bassiana (Naturalis-O/Botaniguard), chlorpyrifos (Duraguard), diazinon (Knox-Out), and fenpropathrin (Tame).

Caterpillars. Beet armyworm, cabbage looper, corn earworm, European corn borer, and fall armyworm can infest garden mums. Caterpillars can infest almost all aboveground 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 acephate (Orthene), *Bacillus thuringiensis* (Dipel), bifenthrin (Talstar), cyfluthrin (Decathlon), fluvalinate (Mavrik), and permethrin (Astro).

When using chemicals be sure to read the label and wear appropriate protective clothing. Also, apply chemicals when the environmental conditions are favorable to avoid phytotoxicity.

For Further Reading:

- Larson, R.A. and I.F. McCall. 1995. Garden chrysanthemum culture the easy way. *North Carolina Flower Growers' Bull*. 40(6):1-3.
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- *Yoder Garden Mum Cultural Manual*, 1996-1997.