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FIELD PRODUCTION OF CUT FLOWERS: A PRIMER

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(The following article is the first part of a two-part series discussing field production of cut flowers. The second portion of the article covering production, harvest and postharvest requirements of field grown cuts will appear in a later issue of the NCCFG Bulletin. Holly is a Ph.D. candidate in the department working with Dr. Nelson and Dr. Bailey at NC State.)

Consider the following scenarios: you have under- (non-)utilized land around your nursery or greenhouse facility. There are four acres of lawn behind/in front of your house. Business is slow or nonexistent in the summer; you have to let your workers go; there is little cash flow. Martha Stewart's on the TV, demonstrating flower arranging techniques...hmmm...are you thinking what I'm thinking? A field-grown cut flower business is a viable option to fill in the summer production and cash flow gap. The term "cut flowers" includes plant material both fresh and dried or preserved. Buds, flowers, stems, branches, seed heads, stalks--any plant parts used for floral and decorative purposes are considered cut flowers. The number and diversity of available crops is virtually limitless. This publication is not meant to be an all-inclusive manual but as an overview and to simply answer some common

questions to help decide if the field-grown cut flower business is for you.

Why Grow Cut Flowers?

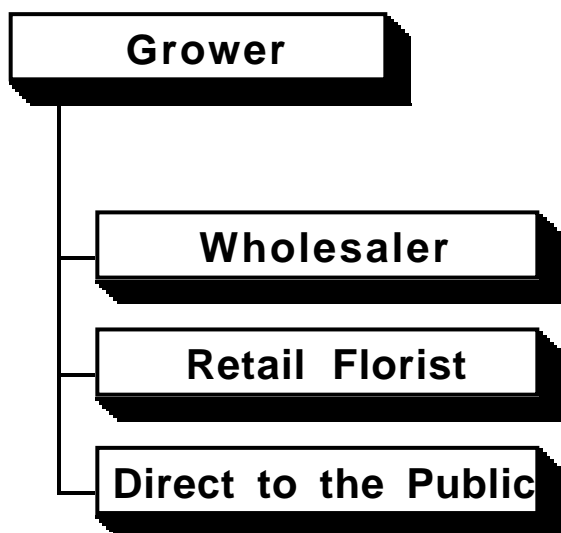
The cut flower market in the U.S. has changed dramatically over the years. The Dutch dominated the flower growing market in the '80s with new varieties. Competition from Third World countries increased as they took a lion's share of the "traditional" domestic cuts market. Rising freight costs put a damper on shipping from one coast to the other. In the U.S., the once-profitable production of standard crops like mums, carnations and roses have been supplanted by nontraditional and specialty cuts. The U.S. flower consumption market, though not nearly as sophisticated and well-developed as the European and Japanese markets, has incredible potential for expansion. Growing market segments exist, such as supermarket floral departments. Large

quantities of cuts are imported into the U.S. from Holland, Central and South America, and the Caribbean. However, there still is room (and profit) in the cut flower business for the savvy grower. Some relatively high-dollar crops do not ship well and are best produced locally. Local production usually equals longer vase life. Understand that the cut flower market is based on supply and demand, but you can often create your own demand by offering high quality and unusual product with reliable service to back it up. Crops produced in the cooler "shoulder" seasons can demand a higher price while the market is not flooded with product. Especially in reference to the small or starting grower, the following phrase is repeated over and over in the both the research and industry literature: *Quality sells*. Grow for quality, and don't be afraid to charge for it. Price will follow quality.

Who or Where is My Market?

Don't wait until you have harvest-ready flowers to decide their fate! Your target market influences what you will grow, how it will be handled and packaged, and most important, your capital investment. Have a clear market plan established ahead of time.

Your marketing options include selling to wholesalers, florists or other retail outlets, and



direct to the public. The obvious route when first starting out is to target local markets. As volume increases, you may want to deal with wholesalers and distributors.

"Direct to the public" sales include farmer's markets, roadside stands, or cut-it-yourself arrangements. How much you wish to truly interact with the public can help determine if a cut-your-own business is right for you. On-site sales, whether in the field or from a stand, requires a good location in a populated area, and a desire to deal with (not a mere tolerance of) the public. Production considerations may be altered a bit for the "cut your own" concept (*the production section will appear in Part II of this article*). If you are integrating a field cut flower business with a preexisting greenhouse or nursery that retails to the public, additional marketing requirements can be minimal.

There are many direct-sales opportunities away from the farm as well, though transportation now becomes a cost factor. Farmer's markets offer a low-overhead market for novice growers. You can experiment with displays, mixed bouquets, dried materials, etc. and enjoy relatively autonomous pricing. There are many other retail opportunities available, such as a restaurants, banks, etc. Craft shows are great sales venues for preserved and dried plant material.

Sales to retailers such as florists, garden centers, grocers, upscale or "gourmet" specialty stores are another option. Dr. Alan Stevens suggest that for businesses other than florists, start with a few sizes of mixed bouquets, then move to quantities of single species. Offer pre-made bouquets as a labor-saving option to florists. Florists are constantly searching for new and unusual material. For more information and a membership directory, contact the North Carolina State Florists Association at 1100 Broad Street, Durham, NC 27705.

Selling to wholesalers entails meeting their grading, sorting and packaging requirements, and consistency is greatly appreciated. Though price will be lower, wholesalers will often accept

large quantities. If you are selling both to retail florists and to wholesalers, offer a quantity-based price break. Be aware that when dealing with wholesalers, payment is usually made 30 to 45 days out. Don't expect COD terms. Also, consignment sales are not recommended. If you're offering your product at wholesale prices, let someone else do the marketing and make the retail contacts. If you form a relationship with a wholesaler, don't undercut them by selling directly to his/her retailers. For a directory of wholesale florists and florist suppliers contact the Wholesale Florists & Floral Suppliers of America, P.O. Box 7308, Arlington, VA 22207, 703.241.1100.

Last but not least, the Internet offers a new marketing niche. You can provide product information in a website to potential customers and create interactive order forms for use with browsers such as Netscape and internet connection services such as America on Line.

The Web is also useful for following price trends: the USDA publishes wholesale cut flower prices from major city markets such as Miami, New York, and San Francisco. Penn State University offers access to this information at their web site <http://psupen.psu.edu:701%24m%201019956>. Market information is also available at <http://www.flora-source.com>. Wholesales pricing to retailers for over 100 specialty cut flowers is also available from this site - go to the Dos Osos Multifloro homepage (a progressive and quality wholesaler out of central California) in the Marketplace section. Try to establish one consistent factor in your pricing. Some examples include: the same number of stems per bunch regardless of species; the same price per bunch but vary the number of stems (good if offering a large assortment of unusual material).

Regardless of your market, consistency of quality and service should be your business goals. In order to compete with the offshore market (lower price), local growers must offer comparable quality, grading, packaging, and

promptness. Educate your buyer! Provide price lists, quantities available, descriptions if the material is unusual or not well known, postharvest recommendations--anything to improve quality and service.

Product Variety: Find Your Niche

Flowers can be grown either specifically for fresh use, dried use, for parts other than flowers such as seed pods, or any combination of the preceding. Start with species or varieties proven to grow in your area (climate!). North Carolina's climates are as varied as its geography. Introduce other species on a trial basis before committing to large-scale plantings. An interesting industry trend is smaller acreage for cut flower production --1 to 2 acres. Overproduction is often a problem --most local markets can't accommodate the volume produced on 20 acres of cut flowers, no matter how beautiful they are!

What should I grow? There are annuals, perennials, grasses, woody shrubs, trees and vines all suitable for use as cut flowers or plant material.

Annuals will produce in the year planted and most are easily started from seed. Annual seed is readily available and lower cost compared to perennials and bulbs. Tender or half-hardy perennials can be grown as annuals.

The choices for perennials are endless. Some traditional perennial crops that bring a good price include peonies (both fresh and dried), lily of the valley, and calla lilies. Garden roses with fragrance are a possibility for the specialty florist market--also the "antique" cabbage and bourbon-type roses would fetch top dollar during the wedding season.

Woody species extend production time to include early spring flowers (either naturally or on forced branches), summer flowers (*Buddleia* spp.) late season berries, or ornamental stems such as the corkscrew willow (*Salix matsudana* cultivars) harvested in the fall and winter. Relatively low maintenance and long-term production are benefits of including "woodies" in your field-grown cuts program. Do keep in

Consider these rules of thumb from Dr. Alan Stevens, cut flower specialist from Kansas State University, when deciding on potential crops:

- ⇒ high production (number of stems) per square foot of bed area
 - ⇒ long, productive life plus extended production season
 - ⇒ long stems (18" or longer)
 - ⇒ minimal pollen shed
 - ⇒ postharvest vase life of no less than 7 days
 - ⇒ resistant to heat, drought, pests, and pathogens
 - ⇒ ability to sell surplus as a dried or preserved product
 - ⇒ ease of harvest and handling
- and last but certainly not least:
- ⇒ aesthetically pleasing!

mind that it may take a few years for some species to reach marketable harvest size.

Both wholesalers and florists want to be the first with unusual or improved varieties. If you have the space, consider a larger product mix. A wide variety of cuts allows you to service a greater percentage of the needs of your customers. Consistently test new crops. The ability to provide the floral wholesaler or retailer with unusual material will make you invaluable! Most wholesalers or retailers will pay for samples of a new variety. In the same vein, be aware of changes in consumer style and color preferences. Comb the pages of greenhouse, floral, and horticultural science publications to get the skinny on what's hot. Look for the best cultivars of a particular species you want to grow. New varieties may offer higher yields and better pathogen

resistance. Be cautious when "copycatting." If a species is particularly popular/profitable this season, chances are good that it will be available in mass quantity the following year.

For invaluable information on everything from new cultivars to production techniques, join the premier cut flower organization - the Association of Specialty Cut Flower Growers (ASCFG), M.P.O. Box 268, Oberlin, OH 44074-0268. This group offers bountiful information in the form of a great newsletter - *The Cut Flower Quarterly*, plus access to back issues, cut flower-related publications, and Association conference proceedings.

What are the Costs of Cut Flower Production?

Comparatively little work has been done on the economics of field production of cuts (many sources have developed budgets for outdoor production of vegetables - these can be valuable references). The categories of overhead and variable costs are roughly similar to those incurred in greenhouse production, but there are some important differences.

Robin Brumfield, Agricultural Economics Extension Specialist at Rutgers University, recommends tracking costs with the following system: Variable costs are allocated to each unit of production. These costs of production will change as the units of production change. Overhead or fixed costs are incurred without regard for the number of units produced. As more units are produced, the fixed cost per unit decreases.

Variable costs include materials such as fertilizer, lime, plants, chemicals, etc. Production labor is also allocated to each unit. If you are already in the nursery or greenhouse business, you are probably aware of the factors comprising total labor costs per hour - not just the hourly rate, but social security, workmen's comp., unemployment and disability insurance, and paid holidays. Be sure to include these, if applicable, when calculating total labor costs per hour.

Overhead costs are not allocated to a specific crop. Costs must be allocated by some other method, such as cost per acre. Overhead costs include irrigation equipment (don't even CONSIDER not having irrigation) and related fertilizer proportioners, storage tanks or farm ponds. Machinery, equipment and buildings make up a substantial percentage of fixed costs. Tractors, fertilizer spreaders, sprayers, carts, wagons, delivery trucks/trailers, coolers, sheds, office buildings, etc. are all considered initial investments. Depreciation on these items should be calculated in terms of "useful life".

Keep good records, be cognizant of all costs involved on a daily basis to be sure you are receiving fair value for your product. Develop a business plan and stick with it! Experts advise against increasing the size of your business until you know it is profitable.

Don't be timid concerning investing in new technology. The labor (read: cost) savings can be substantial. Also understand local environmental regulations, both current and impending. Invest in facilities and techniques that lessen dependence on chemicals.

References and Recommended Readings

Armitage, Allan M. 1993. Specialty Cut Flowers. The production of annuals, perennials, bulbs and woody plants for fresh and dried cut flowers. Varsity Press/Timber Press, Portland, OR (800) 327-5680. *(Contains A to Z production information from the leader in discovery and development of specialty*

cut flower crops. Coverage by genus and species includes propagation, environmental requirements, field and greenhouse performance, harvest and postharvest, and pests and diseases.)

McAvoy, Richard J. 1997. Annuals for Field-grown Cut Flowers. Connecticut Greenhouse Newsletter 197:1-8.

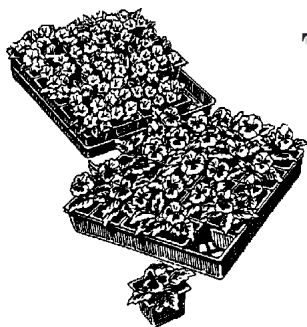
Reid, Michael and Linda Dodge. 1996. Cut Flowers: Postharvest Handling Review. In: The Cut Flower Quarterly. 8(1):23-24.

Stevens, Alan. 1996. Field Grown Cut Flowers: A Practical Guide & Source book. Avatar's World 800.884.4730. *(This reference book covers management, marketing, production, specific crop information, mistakes to avoid, and reams of sources and directories. Dr. Stevens is a noted cut flower specialist and consultant.)*

Cut Flower Organizations

The Association of Specialty Cut Flower Growers. ASCFG, Inc. MPO Box 268, Oberlin, OH 44074. Ph. 216.774.2887. *(The quarterly newsletter that accompanies membership is an excellent resource for new crop information, marketing tips, industry news and research updates.)*

(The author wishes to thank the countless grower contributions to the Cut Flower Quarterly that helped comprise this article.)



Don't Miss

The NC State University Bedding Plant Field Day

Wednesday, 30 July 1997

Horticulture Field Laboratory and McKimmon Center
Raleigh, NC

Call the NCCFGA office at 919.779.4618 for registration information.

NCCFGA NEWS

By the time you get this Bulletin, our glorious spring weather should be drawing to a close. Hopefully it has been a rewarding and profitable season for all.

Your Association has been busy this spring as well. On Thursday, April 10, Bonnie Holloman went to the capitol and delivered plants to the NC House and Senate in celebration of Governor Hunt's proclamation of April being Floriculture Month in North Carolina. Representative John Brown (House of Representatives Chair of House Ag Committee) and Senator Charlie Albertson (Chair of the Senate Ag Committee) were our sponsors for the plant donations. On Thursday, April 17, Joe Stoffregen and Susan Rollins took time out of their busy schedule to join Bonnie at the Governor's mansion to deliver plants to Governor and Mrs. Hunt. Our efforts to promote floriculture in North Carolina were well received. We received letters and phone calls of appreciation from House and Senate members as well as a thank you card from the Hunts.



NCCFGA Executive Secretary Bonnie Holloman with Senator Charlie Albertson, Chair of the Senate Agriculture Committee and our Senate sponsor for the plant donations made during Floriculture Month 1997.



Joe Stoffregen, Bonnie Holloman, Governor Hunt, and Susan Rollins at the Governor's Mansion. Governor and Mrs. Hunt greatly appreciated the flowers given to them by NCCFGA in honor of Floriculture Month.

We also had a strong presence at this year's record-breaking Southeast Greenhouse Conference and Trade Show. If you missed this one, you missed a great one! With 285 trade show booths (33% increase over 1996) and 1,687 participants (27% increase over 1996), this was the best SGCTS to date. NCCFGA is proud to be one of the founding cosponsors of this conference.

Speaking of programs cosponsored by NCCFGA, make your plans now to attend the Bedding Plant Field Day on July 30. You can tour the trial gardens and sit in on sessions targeting perennials and perennial production.

Our annual membership meeting will also be held during the Field Day. We will be electing Officers and Board Members for the 1997-98 season. Call Bonnie Holloman at 919.779.4618, if you would like to make any nominations; we value your input! Even if you can't make the Field Day tour and talks, you can still attend the membership meeting to be held at the J.S. McKimmon Extension Center in Raleigh at 3:50



NCCFGA was well represented at the 1997 Southeast Greenhouse Conference and Trade Show held in Greenville, S.C. earlier this month.

PM on July 30. Contact Bonnie Holloman at for more details on the Field Day or the membership meeting.

This is my last letter as president of NCCFGA. I truly appreciate the support and help of the

Board of Directors and the Officers of the Association. I also would like to thank Bonnie Holloman for all she does as our executive secretary and Doug Bailey for his assistance as the educational advisor to NCCFGA. Finally, I would like to thank you, the general membership for giving me the opportunity to serve in this capacity. Your membership and participation is essential in the survival and growth of our Association and industry. I look forward to seeing each of you at the upcoming Bedding Plant Field Day and General Membership Meeting in July.

Have a happy summer,

Calendar of Events

Event	Date	Time	Location and contacts
NCSU Bedding Plant Field Day	Wednesday 30 July	9:00 am to 3:30 pm	Horticulture Field Laboratory, Raleigh, N.C. Contact Bonnie Holloman at 919.779.4618 for further details.
NCCFGA General Membership Meeting	Wednesday 30 July	3:30 pm	McKimmon Center, Raleigh, N.C. Call Bonnie Holloman for further details.
NCCFGA Board Meeting	Wednesday 30 July	4:00 pm	McKimmon Center, Raleigh, N.C. Contact Bonnie for further details.
Perennial Plant Symposium	Saturday–Saturday 2–9 August		Sheraton Imperial Hotel, Research Triangle Park, N.C. Contact the Perennial Plant Association at 614.771.8431 for more information.
Specialty Cut Flower Growers Conference	Wednesday–Saturday 27–30 August		Doubletree-Lloyd Center, Portland, OR. Contact ASCFG at 216.774.2887 for more information.
NC State University Poinsettia Open House	Thursday 4 December	9:00 am to 3:00 pm	Horticulture Field Laboratory, Raleigh, N.C. Contact Bonnie for more details.

SUCCESS WITH GARDEN MUMS

**Brian E. Whipker, Floriculture Extension Specialist, Iowa State University,
and Raymond A. Cloyd, Entomology Department, Purdue University**

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 °F.

Containers

To help care for the new cuttings prior to their establishment, many growers plant cuttings into

Keys to Success with Garden Mums

1. 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. Proper cultivar selection
7. Calculate your production cost

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.

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 1/2" of new top growth has developed and the roots are visible at the side of the tray pack). Remove around 1/2" 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 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, 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" to 2 1/2" 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 (NO₃-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

Table 1. Guidelines for foliar analysis values (based on dry weights) for mums.	
Nutrient	Recommended concentration
N (%)	4.00-6.50
P (%)	0.25-1.00
K (%)	3.50-6.50
Ca (%)	0.50-2.00
Mg (%)	0.30-0.60
B (ppm)	25-100
Cu (ppm)	5-50
Fe (ppm)	50-300
Mn (ppm)	30-350
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 for Georgia, 1988.	

heavy rainfall is expected due to water pooling on the cloth. A sample schedule for shading plants is given in Table 3.

Scheduling/Timing

An example schedule is given for producing a natural season garden mum, Table 4. This is a basis for planning your schedule, but variations will occur due to variety selection, environmental conditions, and fertility programs. Consult your

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 $\frac{1}{4}$ 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), p. 9.	

Table 3. Early shaded garden mum timetable - 1997. (6" or 6 1/2" pots - one cutting 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	Sep. 01
Based on starting with a rooted cutting. Long days provided until the shade date. Source: Yoder's 1996-1997 Garden Mums Guide.				

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 Kocide 101 77WP (copper

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. Readers interested in costs should refer to their August 1996 NC Commercial Flower Growers' Bulletin for production costs of garden mums (or contact Doug Bailey at 919.515.1195 to receive a copy of the cost article).

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

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 2787 75WP, 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.

Table 4. 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	B-Nine application ³
July 15	B-Nine application ³	
July 29	B-Nine application ³	
Mid-September to mid-October	Flowering ⁴	Flowering ⁴

¹ B-Nine applied after the last pinch when 1 1/2 to 2 1/2 inches of new growth has occurred. Additional 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.

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

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). 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 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,

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 (Ultra-Fine Sun Spray), insecticidal soap (M-Pede), methiocarb (Mesurol), and diazinon (Knox-Out).

Leaf miners. Leaf miners can cause

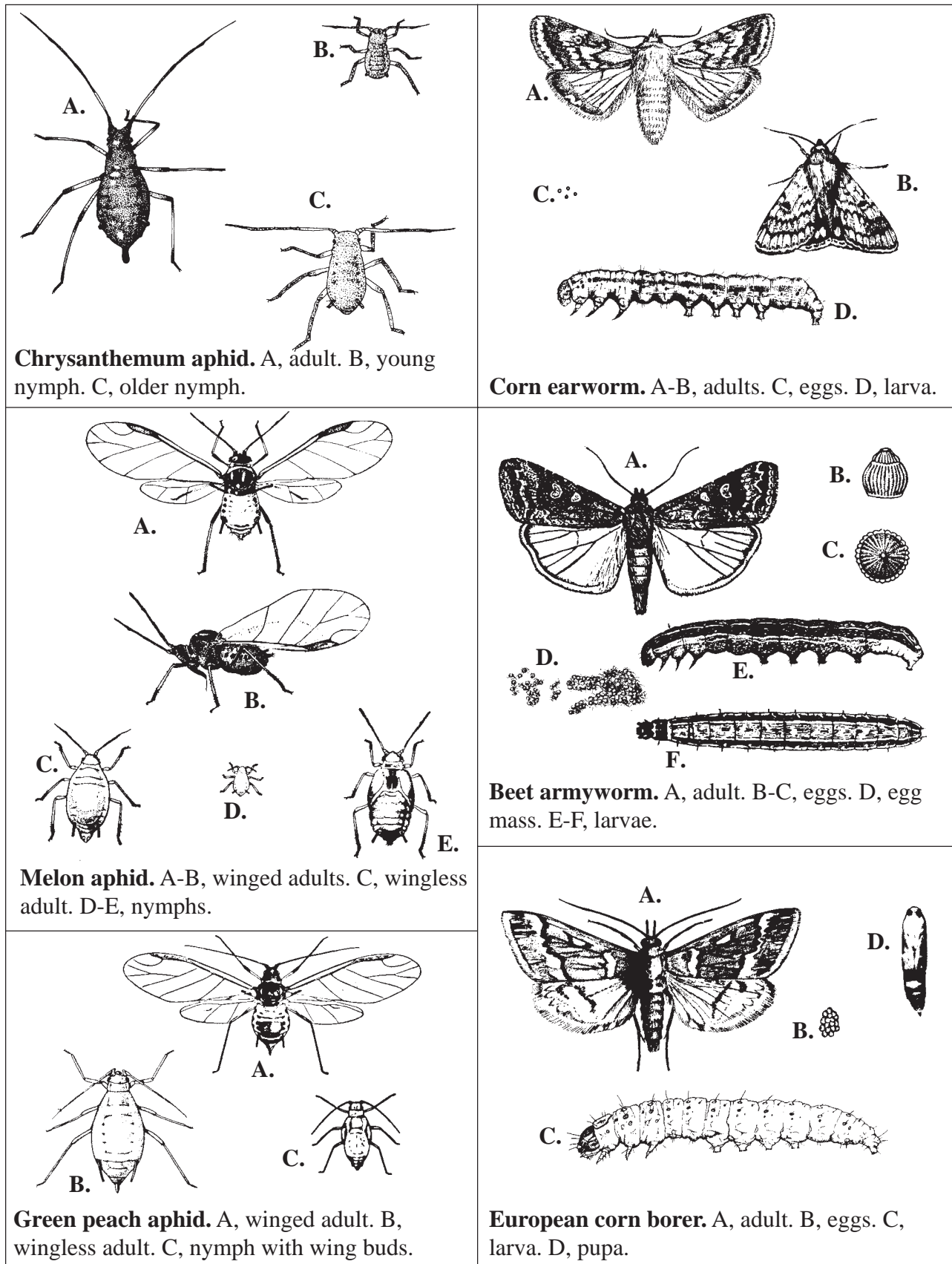


Figure 1. Common Garden Mum Insect Pests. Source: J.R. Baker (ed.). 1994. *Insect and related pests of flowers and foliage plants*. N.C. Cooperative Extension Service Bulletin AG-136. 106 pp.

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 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 °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).

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