White Paper: Garden Mum Culture Summary
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When Cuttings Arrive

Cuttings should be stuck or planted as soon as possible. If the cuttings need to be held for a day or two, hold in a cooler at 33° to 40° F.

To root cuttings, stick cuttings in moist media and apply rooting hormone, if desired. The most efficient way to apply hormone is with a 200 ppm IBA spray the morning after the cuttings are stuck. Use mist to reduce cutting stress while roots are forming. Less mist is best to encourage rooting and reduce cutting stretch. Using an environmental controller to determine mist cycle is ideal. If not, watch cuttings closely and try to leave the mist off in the morning after day three or four. Mist should be off 10 days after stick. Maintain a root zone temperature between 70° and 74° F for fastest rooting and increased rooting uniformity. Applying fertilizer two to three times a week during propagation will also reduce rooting time and can be started between one and three days after stick. Fertilizer rates of 165 to 200 ppm N are often used, with some growers going as high as 250 to 300 ppm. Be sure to use night-interruption lighting during propagation even during May and June. This will help to reduce premature budding.

Plant cuttings as soon as they are rooted to prevent stress on the cuttings. Be sure to plant into moist media and just deep enough to cover the root ball. Always water-in cuttings with a complete N-P-K fertilizer solution containing 250 to 350 ppm of nitrogen immediately after planting. When to plant will be driven by the flowering system (natural versus blackcloth), the finished pot size and the desired ship date. Make sure the pots are adequately spaced to prevent plants from touching and to allow the varieties to reach their full potential.

Temperature

Once the cuttings are in the final container, keep night temperatures above 62° to 65° F to allow growth and reduce the potential for budding. Night temperatures in the 50s (F) can cause garden mum bud initiation and potential development even under long day conditions. Plant outdoor crops in mid to late June after the night temperatures are above 60° F. This will allow for more growth than planting in late May because of a lack of cold night temperatures and premature bud initiation.

Growing Medium Selection

For mum production, the growing medium should retain adequate water after irrigation but also drain sufficiently to provide aeration during rainy weather. Many growers use peat-based mixes commonly used for bedding plants and baskets. Some growers prefer heavier bark-based mixes. Of the two types of growing medium, bark-based mixes are more porous and might require 20% more nitrogen with the feed program. In either case, be sure that the growing mix is well drained with 12-18% air-filled pore space. The pH range should be 5.8 to 6.2. If a very light weight mix is used, large plants can be top heavy and prone to tipping over in windy conditions. If this is a problem, use a growing mix that contains a heavier component (like bark) to provide weight and stability to the pots. Fafard 2 Mix, 3B Mix, 51L Mix and 52 Mix are often used by mum growers. The #2 mix is light-weight, 3B is middle-weight, and #52 is a heavy-weight product.

Irrigation and Fertilization

Irrigation with a drip system not only creates a better environment for the plants, but also can be designed to significantly reduce water and fertilizer waste. Plants should not be allowed to wilt during the first third of the crop time as that can have negative effects on the finished plant. During the final phase, restricting water can be used to tone the plant and prevent overgrowth.

Mums are relatively heavy feeders. Growers can utilize a water soluble fertilizer, a controlled release fertilizer or even a combination of the two, depending on preference. Lack of fertility during the vegetative development phase (first half of the crop) will adversely affect plant size and quality. High fertility levels can help overcome crown-budding but can also delay flowering. During the flowering phase, nutrient demand drops by half and fertility should be reduced.

Water Soluble Fertilizer (WSF) Usage

The first five weeks of the crop are critical. Check your feed system and injectors before you plant the cuttings. Growers should use a complete N-P-K with trace elements fertilizer with a 2-1-2 or 3-1-1 ratio. During the first half of the crop cycle EC values of 2.0-3.5 mS/cm (SME extract) or 2.5-4.5 mS/cm (pour through extract) should be maintained. Start the liquid-feed program 3 days after sticking un-rooted cuttings and at the time of planting for rooted cuttings. We recommend a high level of fertilizer (250 to 350 ppm N) from a constant liquid-feed program to get the plants started. Some growers use an ammonium-based fertilizer for the first 2 weeks and then switch to a higher nitrate fertilizer. Fertilizer rates can be reduced once the plant body has been built and/or once there is a need to irrigate more than once a day. The application rate might have to be adjusted to accommodate weather conditions or the degree of leaching that occurs.

WSF formulation selection should be based on water quality. Have your water tested and use acid injection to reduce high water alkalinity (greater than 150 ppm bicarbonate) to prevent water pH issues at the source. If water alkalinity adjustment is not possible, acidifying WSFs like 20-10-20 can be used to help counteract the pH increase. When the water is low to moderate in alkalinity, neutral to basic fertilizers, like 15-5-15 Cal-Mag, should be used in conjunction with a 20-10-20 to maintain an optimal soil pH. Liquid feed programs using WSF's allow the grower much control and flexibility with the fertility program. WSF usage is best suited for use with pot to pot drip-tube type irrigation. Because of pot spacing, when overhead sprinkler irrigation is used a lot of the applied fertilizer becomes runoff and is wasted. Because of waste and runoff concerns, mum growers using overhead irrigation may want to consider the use of controlled release fertilizers.

Controlled Release Fertilizer (CRF) Usage

Some mum growers use CRF instead of liquid feed. Be sure to use one that contains trace elements. CRF can be incorporated into the growing medium prior to planting or top dressed after planting. If at all possible, water in the plants with a WSF to boost initial fertility. CRF release is temperature dependent, releasing faster during warmer weather. CRFs are categorized by release rate in months or days. Northern growers often use 3-4 or 5-6 month products while southern growers use 5-6 or 8-9 month products. The recommended application rates vary by product and are listed on the labels. High application rates are required to provide adequate nutrition. Growers should take great care when selecting a CRF and its application rate, especially if there is no way to apply supplemental WSF if needed. Depending upon weather conditions, it is sometimes necessary for additional top-dress applications to avoid low fertility. Growers should regularly monitor growing medium electrical conductivity (EC). Low or decreasing EC values would indicate the need for supplemental fertility.

Water Soluble Fertilizer/Controlled Release Fertilizer Combination

Some growers produce mums alongside lighter feeding crops using a single injector. With this system, heavier mum fertility requirements can be accommodated by including a light to moderate CRF application to the crop. This provides continuous low to medium fertility levels supplemented by the liquid feed.

Photoperiod Control

Long days are needed for vegetative growth. A sufficient number of long days must be provided to obtain the proper finished plant size for a given container. Artificial long days should always be provided during mum propagation, and during the long day period with spring and blackcloth crops. Artificial long days can be supplied by lighting plants from 10:00 p.m. – 2:00 a.m. with 10 – 15 foot candles or 1.5 to 2.0 w/m2. This can be obtained with 100 watt incandescent bulbs or 33 watt corkscrew-type compact fluorescent bulbs. A typical set up would be to have light lines ten feet apart and incandescent bulbs placed every ten feet down the light line. When using compact fluorescent bulbs, additional bulbs are necessary and should be spaced every five feet down the light line. Even with the additional bulbs, there should be a 33% energy savings using the compact fluorescent bulbs. For either bulb, a reflector (pie pan) is recommended to be sure the light is directed down toward the plants. Use a timer to control when the lights go on and off. Use of artificial “mum lighting” should be done even when the natural day length is greater than 12 hours, to ensure the cuttings do not initiate flower buds early.

Short days are needed for flowering. Artificial short days are provided by covering plants with an impermeable light barrier like blackcloth or four to six mil black plastic for at least 12 hours daily. Accomplish this by pulling blackcloth before the sun sets and opening after sunrise (7:00 p.m. – 7:00 a.m.), or by pulling blackcloth early in the morning before the sun rises and opening mid- to late morning (5:00 a.m. – 10:00 a.m.) to help reduce the temperature under the cloth during the night. Light intensity under the blackout must be less than two foot candles to be effective. For the most predictable timing, we recommend covering every night for at least four weeks to initiate flowers. When using blackcloth outside of the greenhouse, some growers use weed barrier cloth since it allows the passage of air and water. Blackcloth can be laid directly atop plants, but most often a support structure is used to prevent damage from windy or rainy conditions. The covering is pulled over the structure at the end of each day from either the sides or ends of beds, and then rolled and stored in the aisles in the morning.

Pinching

By using today's free branching varieties along with a good fertilizer program, pinching is no longer required for producing garden mums. Some growers may still want to give one pinch if they are located in an area of the country with low humidity or if more spread is needed on varieties grown as a blackcloth crop. Many of the newer varieties will actually start branching during propagation, well before many growers would even consider pinching.

Growth Regulators

Growth regulation may be needed for the production of garden mums in order to meet certain crop schedules and growth targets. If most of the varieties in your crop require growth regulators, consider a later plant date to reduce growing time and, therefore, plant size. Proper use of fertilizer and irrigation can also help control plant size later in the crop (see the Fertilizer and Irrigation sections).

B-Nine® plant growth regulator is a common regulator used for the production of garden mums. Typical spray rates range from 1,000 – 5,000 ppm with 2,500 ppm as a traditional starting point. Rates vary depending on a variety's vigor, temperature and growth stage of the crop. Usually no B-Nine is applied after the buds reach pea size to avoid flower discoloration and delay.

Bonzi® plant growth regulator is also an effective tool that can be used to regulate plant growth. The active ingredient in Bonzi is absorbed by roots and stems and can be applied as either a spray or drench. Spray rates range from 30 – 50 ppm, while drench rates range from 0.5 – 2ppm. While drench applications can be applied at any point during production, foliar sprays are best used after transplanting up until the early stages of bud formation. Drench applications can be particularly helpful at the end of the crop cycle to maintain plants at their finished size prior to shipping. Late applications using low drench rates does not appear to delay flowering. Use rates and application frequency will vary based on the vigor of the variety and the climate in which it is grown. It is always best to trial at a lower rate first, especially when growing in regions with cooler climates and for first time users.

Sumagic® plant growth regulator is also a very effective, but results have been more variable. Spray rates range from 2.5 – 10 ppm and drenches of only 0.1 – 1 ppm are used. Uptake of Sumagic is similar to Bonzi.

Florel™ has been promoted for several uses on garden mums: to increase branching, to prevent premature budding and to delay flower dates of the same variety. More recently, Florel is being used by some growers to replace night interruption lighting during the long-day period of the crop schedule. In our trials, we have not found Florel to increase the branching of garden mums as it does in other crops. With the free branching garden mums now available, Florel is not required to have well branched plants. Growers have been successful in using Florel as insurance against budding by spraying the cuttings while in propagation and/or shortly thereafter. Rates of 350 to 500 ppm are commonly used with spraying frequency of every 10 to 14 days. Florel by itself will not solve a budded cutting issue after buds are visible on the cuttings. Premature budding is best prevented with the use of long-day lighting and optimal temperatures, and best overcome with a strong fertilization program to push growth around the buds.

Florel can be successful in delaying flowering and may even work as a long-day lighting substitute. Unfortunately, flowering uniformity will be adversely affected on some varieties when Florel is applied, as all of the stems do not respond the same.

Pest Problems

There are several insect pests, including aphids, mites, various caterpillars, leafminer, whiteflies and thrips, that can be a problem on garden mums. Fortunately, insects are not usually a significant problem, but pressure can vary from region to region. Previous scouting data can provide a history of which pests are more prevalent in your area and help provide a framework for a building a preventive program for routine pests. Avid® and Flagship® insecticides, with their broad spectrum activity across some of the major garden mum pests, will be two important products in your insecticide rotation program. Some suggested control measures for various pests are listed below.

Aphids - Endeavor®, Avid®, Flagship®

Fungus gnats & Shoreflies – (Primarily a problem in propagation) Citation®, Distance®, Flagship®

Leafminer – Avid®, Citation®, Flagship® (*drench applications for longer control*), Conserve®

Two-spotted spider mites – Avid®, Pylon®, TetraSan®

Whitefly – Avid®, Endeavor®, Flagship®

Caterpillars – Scimitar®, Conserve®, Pylon®, Dipel®

Thrips – Avid®, Pylon®, Conserve®, Mesurol®, Overture®

Scimitar® GC and Mesurol® 75 are restricted use pesticides

Leafminer

Leafminer pressure can vary from year to year and, if not recognized in time, this pest can cause serious damage on garden mums. It is important to inspect plants upon arrival and note any active mines. Monitor the growing areas with sticky cards so you can check for adult activity. Good scouting and proper use of effective controls is the best way to protect crops that are prone to leafminer. A preventive approach is best, as once leafminer gain a foothold in the crop it is often difficult to get them under control. This is due to the unsynchronized timing of the different life stages and the difficulty of getting good spray coverage once the crop has gained some size. The products listed above are the most effective when used in a block rotation of three spray applications. This targets the lifecycle of the pest and allows you to effectively rotate to another product to help minimize the chance of resistance. The systemic activity of Flagship provides extended protection of 4 - 8 weeks (*depending on the rate used*) when used as a drench. This is best applied once the crop has rooted in well, in order to maximize uptake. A rotation of Avid > Citation > Flagship (*drench*), with Conserve saved until the end of the crop if needed for Thrips control, should provide good control throughout the crop cycle. Products containing *Azadiractin* can be applied at the end of the week (or 4-5 days after a treatment of Avid, Citation or Conserve) if pressure is high and/or during the third week prior to rotating to the next product.

Disease Problems

The most common diseases found on garden mums are caused by *Pythium, Fusarium, Rhizoctonia*, Botrytis, foliar leafspots caused by *Alternaria, Septoria,* and *Pseudomonas cichorii (bacterial leaf spot).* The first defense for disease prevention is to start clean. Use clean cuttings, soil/planting media, and equipment as well as good cultural practices in order to create an unsuitable environment for disease organisms.

For the field, be sure the ground cover is free of weeds and debris to remove any potential inoculum source from last year. Prior to placing plants in the field, clean irrigation lines by flushing with chlorinated water containing 2 to 3 ppm chlorine, followed by a 1 ppm chlorine rinse to clear out any debris. Please note that this may cause some clogging in the lines as algae and other debris is dislodged. Be sure to check drippers after flushing and replace those as needed. Zerotol™ fungicide can also be used to clean and flush irrigation lines. Be sure to check the label for the instructions on applications and use rates. It is also important to check for low spots in the field that can be collection points for excess water after rain or irrigation. These areas can contribute to root rot and other disease problems. If the low spots cannot be properly leveled, raising pots up on trays in these troublesome spots can help alleviate future disease problems.

Other cultural practices that can help reduce the risk of disease include moving from a high-ammonium fertilizer to one with a nitrate form of nitrogen after initial growth has begun and maintaining the soil pH at the higher end of the desired range. It is also a good idea to use as and filter and chlorinate the irrigation water if it is from a surface water source.

Disease Control

Infections by *Fusarium* sp. can cause root, stem and foliar blight on garden mums. If this disease has been a problem in the past, a preventive fungicide program can be beneficial for producing a healthy garden mum crop. A rotation using Heritage® fungicide (0.5 – 0.9oz/100 gal) as a drench four weeks after planting, followed by a Medallion® fungicide drench (2oz/100 gal) four weeks later and then finished with a Heritage spray (4oz per 100 gal) focused on the center of the plant three weeks after the Medallion treatment will provide protection against *Fusarium sp.* and many other diseases such as *Rhizoctonia*, Rust and foliar leafspots that can affect garden mums. Please refer to the product labels for specific instructions on applications and use rates.

Pythium root rot can also be a problem in garden mum production, particularly in crops grown outside. The heat of the summer months and the periodic rains can sometimes put additional stress on the root system which can make them prone to infection. Build up of salts in the planting media can also contribute to root problems, so monitor the EC and pH regularly to be sure it is within the proper range. Using a preventive fungicide rotation can help avoid problems that can show up in the crop and disrupt sales. Begin by drenching mums after transplanting or 7 days after stick. The following products listed below have shown to be effective in controlling diseases caused by *Pythium sp*. For prevention, apply on a 21 – 28 day interval; for active infections apply on a 14 day interval. Products should be used in a rotation to avoid problems with resistance.

MOA #	Fungicide	Use Rate (per 100 gal)
4	Subdue Maxx® (Mefenoxam)	1 – 2 fl oz
3	Truban® (Etridiazole)	4 – 10 fl oz
21	Segway™ (Cyazofamid)	1.5 – 3 oz

For more details on chrysanthemum insect and disease management, see the Chrysanthemum Pest & Disease Control tip sheets at www.syngentaflowersinc.com.

Note: These suggestions are only guidelines and may have to be altered to meet individual growers needs. Check all chemical labels to verify registration for use in your region.

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