



Garden Mum Production from Rooted Cuttings

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Fall garden mums represent an important revenue stream for many growers. While traditional production methods can produce a good crop, adopting a newer philosophy will help growers to produce a uniform, strong, and well branched plant with less effort and greater predictability. Our recommendation is to eliminate the physical pinch, substituting a Florel treatment or no pinch. These methods are proven and work reliably with current genetics. With less manual labor, growers can maintain both quality and profitability.

Planning the Crop

Variety and Liner Considerations

Varieties are grouped by response time, flower form and general habit. Most growers focus on early-, mid-, and late-season varieties for their fall crop. Depending on location and market demand, very early or season extenders may also be utilized. Response time indicates the typical weeks to finish following flower initiation. The response groups general flower as listed below. However, environmental conditions, such as unusually cool or warm nights, can alter the initiation date and, therefore, the finish date. For this reason, these dates should be used as a guide only.

Extra Early – for finishing in late August to early September

Early – for finishing in early to mid-September

Mid – for finishing in in mid to late September

Late – for finishing in late September

Season Extenders (Early and Late) – for finishing in early October

Liner material is available from suppliers in an assortment of forms, ranging from un-pinched 50 Strip trays to pinched cell packs. The exact form of the liners received has no impact on finish date and little impact on finished form, as genetics are moving towards more free-branching varieties.

Varieties are also grouped into families, which have similar vigor. When planning larger containers with mixed varieties, it is recommended to utilize varieties from the same family for a pleasing form upon finishing. Some cross-family combos may provide interesting contrast, but timing should match.

Vigor varies across families. Select the best vigor for your pot to avoid a need for excessive use of PGR. It is easier to upsize a variety by increasing fertility than to downsize through PGR use.

Scheduling

The traditional garden mum schedule relied on a hand pinch in finished production to achieve branching. With the newer genetics, this manual pinch is generally not recommended. Instead, a Florel treatment can be used or a No Pinch approach can be adopted (see Controlling Plant Growth, PGRs and Pinching section). Either way, a proper fertility program will

result in a well-branched mum crop without the added labor and removal of effort associated with a physical pinch. After all, a physical pinch removes part of the crop you worked to build.

It's also becoming more common for growers to use a Fast Crop approach. Under this production method, two pinched liners are used per 8" or 9" mum pan. A similar approach can be used for a 6" crop. Fast cropping typically uses the No Pinch method (see Controlling Plant Growth, PGRs and Pinching section).

General crop schedules for the various production methods are listed in Table 1. For most crops, the first through the third week of June is considered to be the ideal planting time. The schedules in Table 1 should be modified for season extender programs, for which planting should be delayed until July 25 (wk 30-31). In recent years there has been a trend towards the No Pinch method. Refer to the Controlling Plant Growth, PGRs and Pinching section below for a brief review of this technique.

Table 1. Typical Garden Mum Production Schedules*

	Florel	No Pinch	Fast Crop	Traditional Pinch
Liners arrive	Week 23-25	Week 23-25	Week 27-28	Week 23-25
Florel applied	Day after arrival, prior to transplant	None	None	None
Liners planted	Two days after Florel application	Upon arrival	Upon arrival	Upon arrival
High Fertility Period	Increase fertility for first 2-3 weeks of production			
Florel applied	Two weeks after first application (Week 25-27)	None	None	None – perform physical pinch
Florel cut-off date	Last Florel application date is July 4, unless delayed flowering is desired			
Regular Fertility Period	Provide moderately heavy fertility until buds first crack color			
Initiation	Natural initiation generally occurs around Week 30 (July 20), though varietal differences exist			
PGR Application	Rates depend on timing and plant size, (see Controlling Plant Growth section)		None	See Controlling Plant Growth section
Reduced Fertility Period	Reduce fertility from first color to sale			
Early Season Finish	Typically in early to mid September			
Mid Season Finish	Typically in mid to late September			
Late Season Finish	Typically in late September			

* Schedules should be used as a guide; individual crops present unique conditions which often require modifications due to environmental conditions or grower-specific cultural practices.

Finishing from Cell Packs or Liners

Receiving and Holding

Hold liners under full sun and irrigate as needed. Suncald is possible (see Disorders section), but should not present lingering problems. If the liners need to be held for more than 48 hours, provide constant liquid feed at 200 ppm using an acid fertilizer, such as 21-5-20. Avoid holding rooted mum cuttings in the tray for more than a week. Held longer, the plants will harden, risking reduced and/or uneven branching.

Pot Size and Growing Media

Mums can be successfully produced in a number of different soil-less medias. Peat-lite, pine bark and/or coir mixes can be used, however mums grown in peat-lite mixes are more likely to blow over in the fields because they have a lower bulk density. If necessary, adjust the media pH to 5.2 – 6.0.

Transplanting and Spacing

Plant the liners level with the media – avoid deep or high planting. One cutting per pot is generally used up through 9" x 6" mum pans, with three plants per pot used for 12" pots. Fast Crop production utilizes multiple cuttings in the smaller containers.

Water in immediately, preferably with a 20-20-20 or 20-10-20 water soluble fertilizer at 250-300 ppm regardless of the use of controlled release fertilizer in the crop. It is critically important to provide immediate feed to encourage soft growth and free branching. ***Do not delay the start of the fertility program.***

Plants are generally placed directly on the outdoor pad, without shading, immediately after transplant. Final spacing is used from the start of the crop. 8" x 5" Mum pans are grown on 18" to 24" centers, with 9" x 6" mum pans requiring up to 30". Fast crop 6" can be grown on 12" to 15" centers. Larger pots should be spaced so that crops are barely touching at the point of shipping. Crops crowded from tight spacing will show an undesirable vertical or lopsided form at shipping. If adequate spacing is not allowed, increased PGR use should be anticipated.



Image 1. Proper spacing of large pots results in desirable form at shipping.

pH and Fertility

Water quality is very important to consider when managing the fertility for a mum crop. For a nominal charge, the GGSPRO team offers basic water testing, including pH, soluble salts, and alkalinity. Fertilizer and acid injection recommendations, if needed, are provided with the results. A full, laboratory water test is recommended once every two years for mum crops. GGSPRO can provide contact information for a number of reliable laboratories that offer quick turn-around on complete water testing.

The ideal pH for garden mums is 5.4 – 5.8. Often, this can be maintained through use of acid fertilizers. If controlled release fertilizers are exclusively used, acid injection may be required if the irrigation water has high alkalinity. Note that the ideal pH for fall asters, commonly grown alongside fall garden mums, is 5.7-6.2.

Garden mum fertility can be achieved through controlled release fertilizer (CRF), water soluble fertilizer (WSF), or a combination of the two, which GGSPRO refers to as a Half and Half approach. Growers using overhead irrigation find that

a CRF program is more efficient, while growers using drip irrigation often prefer WSF. A Half and Half approach provides both flexibility to adjust the fertility program and protection against leaching from rains, as the CRF provides a constant supply of fertility. Any use of CRF requires the use of WSF in the initial two weeks to meet the heavy nutritional needs of the crop and encourage soft growth to support maximum branching. The CRF formulations outlined in Tables 2 and 3 are selected to provide stable release over the entire production season.

Table 2. Controlled release fertilizer recommendations for crops grown under a CRF only fertility plan.

		Topdress rates per Pot			
	Incorporate	8 x 5 Pan	9 x 6 Pan	10" Dillen Color Pot (2 gallon)	12" Dillen Color Pot (approx. 3.5 gallon)
Florikote* 12-4-11 (100 days)	9 lbs/yard	2.5 tsp	4 tsp	2 Tbls	4 Tbls
pots per bag		1511	944	629	314
Nutricote* 13-11-11 (100 Days)	12 lbs/yard	4 tsp	2 Tbls	3.5 Tbls	6 Tbls
pots per bag		1133	755	431	232
Osmocote Plus* 15-9-12 (8 – 9 mos)	18 lbs/yard	2 Tbls	3.5 Tbls	5.5 Tbls	9.5 Tbls
pots per bag		755	503	274	159

*6 g/tsp for 12-4-11; 5 g/tsp for 13-11-11 and 15-9-12

Table 3. Controlled release fertilizer recommendations for crops grown under a Half and Half fertility plan.

		Topdress rates per Pot			
	Incorporate	8x5 Pan	9x6 Pan	10" Dillen Color Pot (2 gallon)	12" Dillen Color Pot (approx. 3.5 gallon)
Florikote* 12-4-11 (100 days)	5.4 lbs/yard	1.5 tsp	2.5 tsp	1.5 Tbls	2.5 Tbls
pots per bag		2519	1511	839	503
Nutricote* 13-11-11 (100 Days)	7.2 lbs/yard	1 Tbls	4 tsp	2 Tbls	4 Tbls
pots per bag		1007	1133	755	377
Osmocote Plus* 15-9-12 (8 – 9 mos)	10.8 lbs/yard	1 Tbls	2 Tbls	3 Tbls	5.5 Tbls
pots per bag		1511	755	503	274

*6 g/tsp for 12-4-11; 5 g/tsp for 13-11-11 and 15-9-12

Mum crops build body as the result of significant branching early in the crop. To encourage this free branching, growers should encourage soft growth in the first 2-3 weeks of production. This is best achieved through the use of high application rates of high phosphorus fertilizers. Regardless of the fertility program selected, all mums should be irrigated with a 20-20-20 or 20-10-20 WSF during the first 2-3 weeks of production. The frequency of this application will vary depending on the use of CRF, as described in Table 4.

Table 4. Recommended fertility programs for garden mum production.

Timing	WSF Only	Half and Half	CRF Only
First Irrigation	300 ppm	250 ppm	300 ppm
Planting to Week 2	300 ppm constant feed	250 ppm constant feed	300 ppm once per week
Week 3 to First Color	200-250 ppm constant feed	300 ppm once per week	Clear water
First Color to Sale	100 ppm constant feed	Clear water	Clear water

For the main part of the crop, growers using WSF only or Half and Half programs should switch to a lower phosphorus formulation, such as a 20-10-20 and rotate with a calcium nitrate formulation, such as a 15-0-15. The rate and frequency of application during this part of the crop should be reduced from the early rates, as described in Table 4. A rotation of 3-4 applications of the acid feed to 1 application of the calcium feed is recommended. This 3-4:1 rotation will provide adequate calcium for later stem strength while allowing proper management of the media pH. This rotation may need to be adjusted based on the alkalinity of the irrigation water. Regardless of the alkalinity, the important thing is to provide adequate calcium to the crop during this phase of production.

Mums have a heavy demand for iron, and the crop prefers a low pH, ideally at 5.4-5.8. As media pH rises above the ideal range, the availability of iron decreases. Iron deficiency symptoms begin with yellowing of the youngest foliage in the growing tips. Often the veins will remain green, especially at the onset of the problem. Mum varieties vary somewhat in their threshold for showing iron deficiency, so it is common to see the problem begin in just a few varieties, progressing through the field if steps are not taken to correct it. Adjusting the pH down to the ideal range is the first step in preventing or correcting iron deficiency. Contact GGSPRO for help in making this correction by injecting sulfuric acid or by using acid fertilizers (possible in some situations). Even when media pH is corrected, it may be necessary to apply chelated iron to correct this problem. Sprint 138 or 330 can be applied as a drench at 4-5 oz per 100 gallons. Foliar sprays or dry treatments to the soil are not recommended because of the increased potential for phytotoxicity. Never apply chelated iron to plants under water stress. Always rinse the foliage following application of iron to avoid a pitting burn which can occur if the solution is allowed to dry on the foliage.



Image 2. Iron deficiency shows as yellowing in young tissue.

Mums also benefit from additional magnesium, most easily provided with Epsom salts. For constant application, use 2 oz of Epsom salts per 100 gallons along with your non-calcium based fertilizer. Alternatively, pulse treatments of 8 oz per 100 gallons on a biweekly basis, or as needed. Magnesium deficiency appears as interveinal chlorosis of the lower leaves on mums. An alternative would be to use 18-8-17 which is essentially 20-10-20 with Epsom salts already added.



Image 3. Damage to leaves from high soluble salts.

Mums are heavy feeders, but they are still susceptible to high salts damage. The most common causes of high salts damage are drought and applying fertilizer over dry media. Both situations result in the plant perceiving a very high salts event due to the concentration of fertilizer salts around the roots. Avoid drought stress and always apply fertilizer over slightly moist media.

Table 5. Water soluble fertilizer options and rates for garden mum production.

Formulation	Rates for Injection at 1:100, given in oz/gal stock			Notes
	300 ppm	250 ppm	100 ppm	
Acid fertilizer options				
20-20-20	20.4	17	6.8	May add Epsom salts and/or Sprint
20-10-20	20.4	17	6.8	May add Epsom salts and/or Sprint
22-4-16	18.3	15.25	6.1	Includes added magnesium and iron
18-8-17	22.5	18.75	7.5	Includes added magnesium
Calcium fertilizer options				
15-0-15	27	22.5	9	Higher calcium, some formulations include magnesium
15-5-15	27	22.5	9	Lower calcium, includes magnesium
15-0-14	27	22.5	9	Lower calcium, includes magnesium & iron
13-2-13	31.2	26	10.4	Lower calcium, includes magnesium
Other				
Epsom salts	2 oz for constant, 8 oz for pulse			
Sprint 138/330	4 oz for pulse			

Temperature

Temperature control is generally not practiced due to garden mums being grown outdoors. However, temperature can impact the crop. See Disorders, Heat Delay and Disorders, Premature Budding for temperature considerations during finishing.

Lighting and Photoperiod

Mums induce flowering under short day conditions. Garden mums are lit during propagation to prevent early flowering. They will naturally initiate in mid-July unless otherwise delayed by artificial long days or Florel treatment.

Moisture Management

Avoiding extremes in media moisture level is important. Constantly waterlogged soil invites root disease and poor root performance. Under-watering and drought stress can lead to stunting and increase the risk of premature budding early in production. Drip irrigation avoids wetting the foliage and is preferable to overhead irrigation systems. Several foliar diseases are encouraged by leaf wetting and open flowers can also be damaged by overhead irrigation.

Controlling Plant Growth, PGRs and Pinching

In the first two-three weeks of the crop, soft growth should be encouraged to allow for free branching. The growth should not be checked due to drought stress, nutritional stress, pinching or plant growth regulator (PGR) applications during this time. Florel is the only exception to the early PGR rule. Florel is applied early in the Florel Method to keep the mums in a vegetative state and promote branching.

Several PGRs can be effectively used after the initial two weeks. Note that lower rates of PGRs applied earlier will be more effective than heavier rates of PGRs applied later. With respect to cost in use, growers are wide to anticipate plant response and make applications earlier. Popular and effective options are described below:

- **B-Nine – applied as a foliar spray**
Effective when applied at 2500-5000 ppm, depending on vigor and desired finished size. Make the first application when the breaks are 1-2” long. A second application can be made 2 weeks later. Avoid additional applications due to the risk of delayed bloom and/or caused clubby flower displays. The label allows for dips of un-rooted or rooted cuttings for a higher level of height control. Be conscious of the risk of spreading disease via plant dips and discard solution periodically to reduce this risk. Consult the label for requirements regarding personal protective gear.
- **Bonzi - applied as a drench**
Drenches are highly effective and predictable with no negative impact on flowering. The earlier in the crop that a drench is applied the less ppm that is required to achieve the same level of control. Growers new to the use of Bonzi drenches on mums should perform a trial to understand the specific varietal responses under their specific conditions. Suggested rates follow:
 - 1 ppm when plants just reach the edge of the pot
 - 2 ppm at 25-50% of finished size
 - 2 ppm at 50-75% of finished size
 - 3 ppm at 75% or more of finished size
- **Topflor - applied as a foliar spray**
Topflor foliar sprays can be effective when applied early, when breaks are 1-2” long. Rates generally start in the range of 15-25 ppm. Be sure to trial prior to treating an entire crop.

As mentioned earlier, fewer and fewer growers pinch their mums. Breeders discourage the practice in finishing and are actively breeding for varieties that perform well without a pinch. There is, however an occasion when a pinch may be necessary: if the liners reach an excessive height prior to planting, they should be pinched to a height of 3-4”.

Traditional Pinch Method

If a traditional pinched production method is used, a single pinch should be made prior to July 5th. Allow breaks to form to 3-4" long after transplant and apply a soft pinch at this time. The soft pinch should include stem tissue and not just folded leaves.

Florel Method

Florel use is beneficial to garden mum crops in several ways. Most importantly, Florel helps to avoid premature budding later in the crop. Regardless of whether or not liners were pinched prior to receipt, the initial spray helps to maintain a vegetative state and should be applied as soon as possible after arrival. From this point, the goal is to keep the mums under the influence of Florel until initiation is desired.

A second application of Florel made two weeks later will also enhance branching, providing more breaks per plant when compared to hand pinching. Florel also reduces internode elongation, reducing or eliminating the need for other growth regulators later in the season. Labor savings are significant when compared to pinching and few employees are likely to complain about this task being eliminated.

More than two applications can lead to excessive branching and reduced stem strength. ***The last Florel application should be made prior to July 4, unless delayed bloom is desired.***

Special instructions regarding the use of Florel

Foliar spray applications of Florel should provide thorough coverage at a rate of at 500 ppm (1.6 oz/gal). Highly alkaline water may need to be treated in order for Florel to be effective. When Florel is added to your spray tank it must be able to drop the pH of that solution to between 4.0 and 5.0 to work properly. Distilled or acidified water may be needed in some cases. Using Indicate 5 to adjust the pH of the spray water to between 5.5 and 6.0 before adding the Florel will allow the final solution to be in the correct range. Call GGSPRO for more details on the use of Florel or Indicate 5.

Florel and Asters

Asters bloom about two weeks earlier than mums. The bloom time of these two crops can be synchronized by making one additional Florel application to the asters (three applications total).

No Pinch Method

Many of the newer mum cultivars are quite free branching. In an effort to reduce production costs, and these crops can be successfully grown without any pinch or Florel application. Crucial to the success of this technique is planting actively growing cuttings and fertilizing them heavily (300 ppm constant feed), during the first few weeks of the production cycle to encourage the self-branching ability of the plants. Never allow water stress during this time, as this may check or harden growth, resulting in fewer breaks and/or premature flower budding. Early crown budding will often occur, further inducing branching in the plant. Continued use of a CLF program at 300 ppm in the absence of water stress pushes out another set of vegetative material from below the crown buds and a well-shaped mum results, with the crown buds hidden in the plant with no detrimental effects. Be sure to use only those cultivars that the breeders recommend for this program and familiarize yourself with the results by conducting a trial before converting your entire crop to this method.

Fast Crop Method

Some growers plant 2 pinched plants per 8"x 5" or 6"x9" pan during the first 2 weeks of July, and do not provide any additional pinches or Florel treatment. Fast crop 6" pots can be planted at the same time, with one plant per pot. Once again, this method should be trialed prior to adopting it for an entire crop.

Growers sometimes utilize mum netting to help provide support to weak stems, reduce splitting and avoid damage during shipping. Rotation with calcium fertilizer and proper use of PGRs can avoid these problems for most crops. However, jumbo sized crops will often benefit from the added support of a net. Nets should be applied at first sign of visible bud,

about 60-70% of finished size. At this stage, the appropriately sized net is simply draped over the mum. The plant will continue to grow through the wide gaps of the net. A well placed net will be invisible to the consumer, resting 4-5 inches below the flowers, completely hidden by the foliage.

Disorders

Sunscald

Some bronzing of the foliage can occur from sunscald when the cuttings are first placed in full sun. They should rebound quickly from this without any treatment.

Heat Delay

High heat can cause a delay in flowering. Kim Williams at Kansas State University found that elevated night temperature, 80-85°F during the first couple of weeks of short days, leads to heat delay. Note that night temperature is the primary factor, not day temperature. Work by Erik Runkles' team at Michigan State University shows that once buds form, temperature has very little impact on development, i.e. cooling the crop will not delay bloom (though it will increase flower size). John Erwin and Royal Heins demonstrated that high temperatures can also reduce flower size and flower count. Occasionally unusual foliage distortion and variegation occurs on certain cultivars as a response to high temperatures.

Premature Budding (Crown Budding)

As breeders have strived to produce mums with improvements such as better branching, more blooms, unique colors and flower forms, etc., it seems that some of the photoperiod response is less pronounced than it was in older cultivars. As a result pre-mature or crown budding is somewhat more common. Premature budding is considered to be a response to moderate temperatures and short day conditions. However, water stress and low fertility will exacerbate the problem.

When detected early, recovery from premature budding can be achieved. In fact, the No Pinch method described above essentially works due to the occurrence of crown budding. For hand pinched or Florel treated crops, the recovery plan for premature budding is much the same as for growing under the No Pinch method. : increase feed to 300-400 ppm for 7-10 days and avoid water stress. 20-10-20 is the fertilizer of choice if recovery from premature budding is needed. If it's not too late for your bloom schedule, an application of Florel at 500 ppm can also be a helpful tool. The pre-mature buds tend to open up down in the canopy after being covered by fresh new vegetative growth and are of no consequence to finished quality. Shearing off pre-mature buds is very labor intensive and in most cases it yields no quality benefits and therefore is not recommended. If not caught and corrected early, pre-mature budding can result in a crop that fails to size and flowers too soon. Growers should scout crops to detect premature budding prior through early July.



Image 4. Sunscald on newly planted mums.



Image 5. Heat stress can cause unusual foliar symptoms.



Image 6. Premature buds are later buried in foliage following proper fertility.



Image 7. Mum field still free of weeds at season's end with Marengo use.

Weed Control

There are several pre-emergent herbicides that are labeled use on outdoor crops of container grown garden mums. For example, we have had excellent result spraying Barricade over the top of mums a few days after they are planted in the field from rooted cuttings. Other products are also safe for use over mums. Ground cloths and pads can also be treated with herbicides prior to placing the plants. As with pesticide use, growers should rotate their herbicide use to avoid the development of resistance. Contact GGSPro for product options and important tank mix instructions.

Pests and Diseases

Aphids, caterpillars, leafminers, mites, thrips and whiteflies are common pests on garden mums. Occasionally broad and cyclamen mites can cause serious damage to mum crops. Considerations should be made to minimize bee exposure risk to pesticides. Discontinue use of upwardly mobile drench products 5 weeks prior to flowering. Choose spray products with reduced bee exposure risk, discontinue use of products with residual risk two weeks prior to flowering and make pesticide applications in the evening, after foraging has ceased for the day. Contact GGSPro for currently favored products and strategies to control insect and mite pests while protecting pollinators.



Image 8. Damage from cyclamen mites.

Growers should be aware of several common root and crown diseases in garden mums. *Pythium* is the most common root disease affecting mums. Due to the prevalence of *Pythium* in mum crops, a preventative treatment soon after planting is recommended. The first drench applied should bring strong protection against the hot weather pathogen, *Pythium aphanidermatum*. *Rhizoctonia* can cause a web blight that originates near the soil line and is treated with a different class of chemicals than *Pythium*.



Image 9. Distinctive blotch leafminer damage.



Image 10. Severe *Pythium* infection in roots impacts health.



Image 11. *Rhizoctonia* web blight.

Moving further up the plant, growers should also scout for foliar diseases. Certain mum varieties appear to be much more susceptible to foliar diseases than others. Keep good records and remove from your program those varieties that show increased susceptibility. *Botrytis* and various leaf spots can affect the foliage. Bacterial leaf spot is a serious problem during some growing seasons. Splashing water from rain or overhead irrigation can spread this disease from plant to plant. Bacterial diseases are especially difficult to eradicate with chemicals. Copper and mancozeb products are key tools for fighting bacterial diseases and should be use preventatively if any signs or symptoms of disease are detected during scouting activities.

Chrysanthemum white rust (CWR) is a serious disease that the USDA does not currently believe to be endemic to the United States. In an effort to keep this disease from becoming established, nurseries and greenhouses where it is detected are subject to quarantine and infected plants are destroyed. Utilize preventative treatments and learn to recognize symptoms of CWR infection. Suspicious plants should be removed from the crop and evaluated by a diagnostic laboratory.

As for pesticides, contact GGSPro for fungicide recommendations that fit your needs.



Image 12. Bacterial leaf spot.



Image 13. Chrysanthemum white is a quarantine disease.

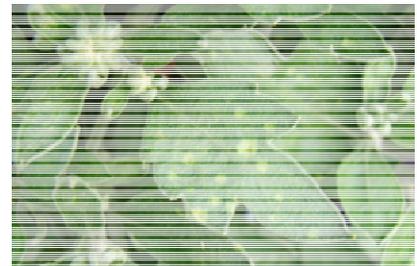


Image 14. Learn to recognize the symptoms of Chrysanthemum white rust.

