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sterilizing pads at the entrances to each greenhouse to minimize spread of foot-borne diseases from greenhouse to greenhouse.

- 10) Clean your headhouse – diseases are often spread on hands and feet from a headhouse facility.

- 11) Eliminate soil under benches if possible. The best way is to simply pour concrete. Fungus gnats, shore flies, and thrips are all big problems in greenhouse production. Soil under benches greatly increases the amount of money you will spend buying and applying pesticides as

this is where these pests can survive and proliferate.

- 12) Purchase needed pesticides and fertilizers now when you know that you can get them!

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Garden Mum Production

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Introduction:

Garden chrysanthemum production has changed dramatically with the introduction of many new types of chrysanthemums. Most notably, the 'Belgian' types of chrysanthemums have increased in popularity and are now prevalent throughout the industry. New problems have occurred. Most commonly, chrysanthemums are not reaching the size growers would like and/or cuttings or plants have buds too early. This review will summarize how to grow a fall mum crop outdoors and avoid these problems. In addition, most problems with a garden mum crop are a result of 'non-optimal' conditions during the first month. Therefore, I will spend

more time reviewing what should be done during that month to insure a successful crop.

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Emphasis on hardiness is coming back! Over the last 10 years, what cultivars have been grown have been based mostly on crop size and flower form or color with little regard to hardiness. Consumers have finally realized this and are

Table 1. List of the hardiest chrysanthemums for Minnesota and the year they were introduced.

Cultivar	Year
Sesquicentennial Sun	2001
Peach Centerpiece	2001
Betty Lou Maxi-Mum	1996
Inca	1996
Snowscape	1996
Rose Blush	1993
Maroon Pride	1989
Mingopher	1977
Burnt Copper	1988
Grape Glow	1988
Lemonsota	1988
Rosy Glow	1987
Centennial Sun	1985
Gold Country	1983
Mellow Moon	1983
Centerpiece	1982
Minnqueen	1979
Royal Knight	1979
Autumn Fire	1977
Golden Star	1977
Minnruby	1974
Minnyellow	1972
Minnwhite	1968
Zonta	1964
Minnautumn	1962
Wayzata	1961
Minnpink	1957

asking more and more about what cultivars are most hardy.

Unfortunately, or fortunately, almost everything that is not derived from a University of Minnesota line's are not hardy in Minnesota! The list of the hardiest mums for Minnesota is shown in Table 1.

Having said this, because our winters have been warmer, some of the new cultivars may be hardy now. In addition, growers who are reading this from other parts of North America where winter conditions are warmer than in Minnesota may find that a number of cultivars are hardy in your area not listed here.

Initial Planting:

New chrysanthemum cultivars can be stimulated to flower if stressed in any way! Because of this, it is critical that you 'baby' cuttings or rooted cuttings from the start! By 'babying' I mean:

- 1) plant or 'stick' cuttings immediately after you receive them. When planting, do not plant too deep - media should just cover the highest roots. If you can not possibly pot the cuttings, place them in a cooler maintained at 33-40°F.
- 2) During rooting of

unrooted cuttings, never allow the cutting to wilt. This will often require that some sort of shade reduction material be placed over or on cuttings.

- 3) Fertilize immediately with a balanced fertilizer with 200-400 ppm nitrogen.
- 4) At no time should rotted or unrooted cuttings wilt! If cuttings/plants wilt, early bud initiation can occur.
- 5) If a bud is present on the cutting, wait 3-5 days until after a rooted cutting roots into the pot and then pinch the cutting.
- 6) Grow in an environment with temperatures between 63 and 80°F if possible.

Container Size:

Garden mums are commonly initially placed in a smaller container until after the first or second pinch and are then transplanted into the final container for finishing. This is, of course, done to minimize field use and maintenance, to have cuttings initially root in an optimal environment, to reduce total labor associated with growing the crop. Cuttings are typically 'stuck' in oasis strips. Rooted cuttings are often transplanted into 1203, 1204, or 1206's, (36, 48, or 72

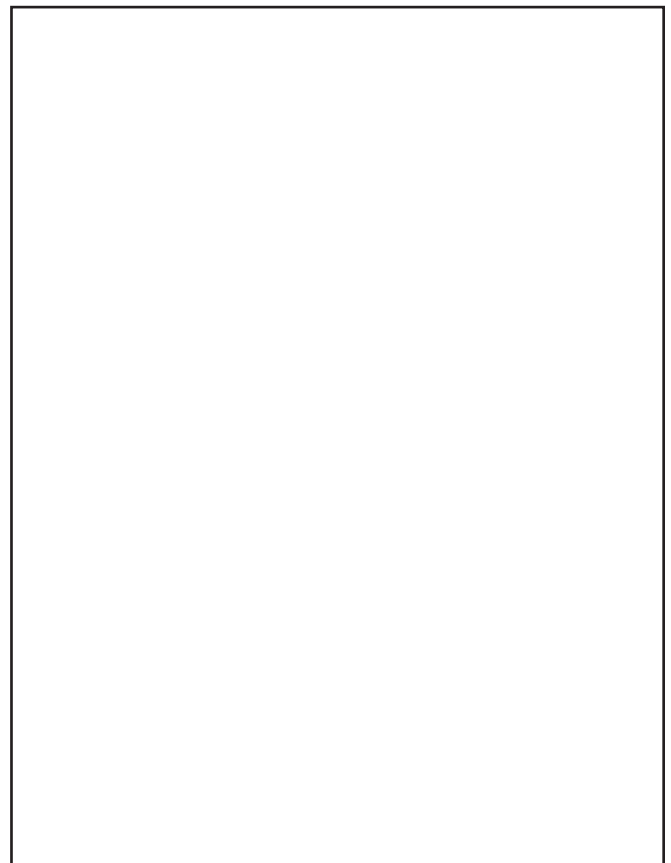
cuttings per flat). Rooted cuttings are then typically transplanted to the finishing container after 2-4 weeks, depending on the initial container size. Finished containers vary in size from 8, 10, 12, and 16" containers. The number of cuttings per container depends quite a bit on the type on garden mum used. Small types, such as Belgians, may require more per pot than older, larger cultivars.

Pinching:

Garden mums need to be pinched repeatedly to achieve the desired size at marketing. In addition to

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traditional pinching, growers will now apply Florel as well to promote maximum branching. The initial pinch should occur 7-10 days after rooted cuttings are planted after cuttings have rooted to the side of the container and 1-2" of new growth has occurred. At this time pinch approx. 1/2" of new growth off. Pinch again approx. after 2 weeks

when 3-4" of new growth has occurred. Regardless, the last pinch date should be no later than July 25.

Florel Application:

Florel application does not substitute for a manual pinch! Although I have heard this repeatedly, I have not found it to be true in Minnesota! However, Florel does promote branching and will reduce stem elongation.

Therefore, spray rooted cuttings with Florel either the day before or after pinching.

The response that you get from Florel varies with the time of year. In general, the cooler and more humid the conditions are when the Florel is applied, the greater the response. In addition, of course, different cultivars respond differently to the same application. In general, most growers find that a spray application of 500 ppm works the best.

In many cases, Florel will not delay flowering greatly, but will improve the form of the plant by reducing stem elongation and increasing branching and compactness. Typical Florel applications times are on day 14, day 28, and day 42 after sticking a rooted cutting. As I mentioned before, the application of Florel

should be associated with a pinch for the first 2 pinches. Do not apply Florel later than 6-7 weeks prior to the expected finishing date.

In general, if Florel is used and plants are grown outside, there is no need for growth retardant applications in most northern climates. However, if growth retardants are needed apply B-9 (2,500 ppm) or Sumagic (4 - 8 ppm).

Fertilization:

THE MOST COMMON PROBLEM WITH GARDEN MUM PRODUCTION IS UNDERFEEDING! For this reason, start feeding immediately, and keep feeding! The first application of fertilizer should be a spray/drench application of 20-10-20 (100 ppm) to unrooted cuttings on day 10. In general, EC (electrical conductivity) readings should be from 2.0 - 2.5. Fertilize with 300-400 ppm of a balanced feed (20-10-20; 15-5-15; 17-3-17) initially until EC levels are 2.5. Do not let EC levels exceed 3.0. On the University of Minnesota Spurway test, EC or Soluble salts levels should not exceed 220. Remember to remove any slow release fertilizer prills before you test media!

pH should be maintained between 5.8

and 6.2 for soilless media and 6.0 - 6.5 for soil-based media.

Because growers often water garden mums outside using a sprinkler system, it can be very difficult to maintain the desired EC levels entirely through liquid application of fertilizers. For this reason, we recommend an application of Osmocote or Nutricote. In general, there is no need for greater than a 3-4 month release time. In addition, there is no need for equivalent amounts of phosphorus to either nitrogen or potassium (i.e. 14-14-14); phosphorus does not leach as readily from media. It is preferable to apply phosphorus through periodic starter fertilizer application or by providing higher phosphorus in the media. Therefore, consider using Osmocote 19-6-12 (3-4 months) or Sierra 17-6-12 slow release fertilizers. Use a level tablespoon when applying as manufacturer recommendations are based on a level and not heaping tablespoon. Ideally, the slow release fertilizer is incorporated in the media prior to planting.

Stop fertilizing liquid feed no later than 2 weeks prior to shipping.

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Flowering:

Chrysanthemums are photoperiodic and are induced to flower by shorter days than nights. In addition, flower development requires shorter days than flower induction. In general, most garden mums require a night length equal to or longer than 9.5 to 10.5 hours. Naturally, most current chrysanthemum cultivars will flower between Sept. 1 and October 10.

Growers can induce plants to flower earlier if you pull black cloth over plants during the end of June. However, if night time temperature 8 hours after the onset of darkness is equal to or greater than 74°F, no flower induction or delayed flower induction will occur. For this reason, do not pull cloth until dusk and pull cloth off later in the morning to limit under-cloth heating.

Shading, will in general, result in flowering approximately 7 weeks later. Therefore, shading starting June 23rd will result in flowering on August 11. Similarly, shading on June 30th and July 7th will result in flowering on August 18th and August 25th, respectively.

Pest Control.

Because a broad variety of pests can attack chrysanthemums outside, consider applying Marathon as this may simplify pest control in the field tremendously. Although it is initially expensive, when you add up the cost of labor and chemical for field application of Marathon will probably cost less!

Otherwise, the most common insect problems in the field are aphids and/or spider mites. Monitor for aphid infestation regularly. Apply a pesticide to those portions of a field that include the infestation. Pesticides effective for aphid control include Orthene, Marathon, Talstar, Tame, Thiodan, Azatin, and Mesurol. Pesticides that control spider mites include Avid, Kelthane, Sanmite, Tame, and Talstar.

Diseases

In general, root rot diseases are not a problem outdoors when plants are in containers. However, the occurrence of foliar diseases can go up quite a bit when growing chrysanthemums in the field versus in the greenhouse. The principal diseases of garden mums are bacterial leaf spot, septoria leaf spot, pythium and botrytis.

Bacterial leaf spot generally occurs during warm and wet periods of the year. There is no cure for bacterial diseases. However, you can reduce spreading of the disease. If bacterial leaf spot is identified, destroy infected plants and spray surrounding plants with Kocide 101 77 WP or Phyton 27 where labeled. These materials do not cure the disease - they simply limit any spreading to uninfected plants.

Septoria leaf spot starts with yellow spots which turn brown. It is fungal, Therefore, control with Captan, Cleary's 3336, Domain or other labeled material.

Both leaf spot diseases are spread by splashing water. Therefore, a cultural method to limit the proliferation of these diseases is to use Chapin tubing instead of overhead sprinklers.

You may consider a spray application of a fungicide that controls a wide range of foliar diseases such as Heritage. Application of any systemic fungicide can be a great preventative that will provide comprehensive control for many, but not all (bacterial diseases) diseases!

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