

envu[®]

Agronomic Recommendations

Chrysanthemum Production



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Introduction

On behalf of Envu, the Green Solutions Team (GST) and the Area Sales Managers invite you to explore this new technical offering designed specifically with you, our customer, in mind. The ornamentals industry generates a tremendous amount of technical content every year, but this content is usually broad in nature due to the diversity of our cropping systems. We at Envu have listened to you and recognize the importance of having all of your technical pest recommendations specific for your crops in an easy-to-use reference document.

In the pages that follow, you will find specific disease and insect control programs for chrysanthemum production. If you have any questions as you use this document or have suggestions for improvement, please do not hesitate to contact your Area Sales Manager (ASM) or ornamental GST member.

Thank you for being an Envu customer. We look forward to providing new and innovative solutions to assist you with delivering quality chrysanthemums for your customers.

Envu Solutions

Envu provides a wide range of solutions for your integrated pest management of ornamentals, and your Area Sales Manager can help with your questions.

Pest management begins with a proactive IPM program that includes proper site selection and establishment, scouting, biological and cultural controls, and sanitation.

- The use of sticky cards assists in early detection of insect pests and proper identification of the pest.
- Within the nursery or greenhouse, sanitation, including the removal of weeds and debris, and cleaning of irrigation lines provides a clean start to the season.
- As the season progresses, rouging heavily infested or infected plants and weighing the cost of losing a few plants against the impact on the entire crop.

Envu provides a diversity of solutions that support your IPM program.

Insecticide	Active Ingredient	IRAC Code	Specialization
Adept®	diflubenzuron	15	Larvae of fungus gnats, shore flies, leafminers, armyworms, lepidopteran and pests; suppression of whiteflies
Altus®	flupyradifurone	4D	Controls piercing and sucking insects before, during, and after bloom
Aria®	flonicamid	29	Sucking pests including adelgids, aphids, scale, mealybugs and thrips
CoreTect®	imidacloprid	4A	Single tablet provides long lasting insect control and slow release fertilizer to ornamentals
Durentis®	chlorantraniliprole	28	Leaf-feeding caterpillars, sawflies, beetles including Japanese beetle, fall armyworm, corn earworm, white grubs, lace bugs, leafminers, aphids and European pepper moth
Floramite®	bifenazate	20D	All life stages (egg, larva, nymph, adult) of the spider mite family (Tetranychidae)
Kontos®	spirotetramat	23	Controls piercing-sucking insects and mites (spider, broad, cyclamen and eriophid mite) at all life stages
OnyxPro®	bifenthrin	3A	Bark beetles, boring beetles, sucking insects, caterpillars, webworms, armyworms, sawflies, weevils, fungus gnats, broad mites and spider mites
Savate®	spiromesifen	23	Control of mites and whiteflies
Shuttle®	acequinocyl	20B	Controls all life stages of spider mite family (Tetranychidae), including Lewis mites (<i>Eotetranychus lewisii</i>). Also controls broad mite (<i>Polyphagotarsonemus latus</i>)
Talstar Select®	bifenthrin	3A	Sucking insects, caterpillars, webworms, armyworms, sawflies, weevils, fungus gnats, broad mites and spider mites
Fungicide	Active Ingredient	FRAC Code	Specialization
Teclera™ (formerly Aliette)	fosetyl-al	P07	Downy mildews, Phytophthora, beech leaf disease, Xanthomonas, fire blight
Banol®	propamocarb hcl	28	Pythium and Phytophthora control
Broadform®	fluopyram + trifloxystrobin	7 + 11	Foliar diseases control; nematode control
Chipco® 26019 FLO	iprodione	2	Alternaria, Botrytis, Cylindrocladium, Fusarium, Rhizoctonia and other diseases
Compass®	trifloxystrobin	11	Controls soil borne and foliar disease
Fame®	fluoxastrobin	11	Highly systemic, soil borne disease control
Terrazole L/WP	etridiazole	14	Phytophthora, Pythium root rot, crown rot and damping off
Herbicide	Active Ingredient	WSSA Code	Specialization
Marengo® FLO and G	indaziflam	29	Long term preemergent control of annual grasses and broadleaves in warm-season turf
Dismiss®	sulfentrazone	14	Controls 190+ broadleaves and annual grasses primarily in cool-season turf
Plant Growth Regulator (PGR)	Active Ingredient	MOA Code	Specialization
B-Nine®	daminozide	1	Ornamentals grown in greenhouses, nurseries and shadehouses

Solutions for Diseases

Root-infecting Pathogens

Preventive fungicide applications can be highly effective when made just as the target organism becomes active, which is usually weeks to months ahead of when visual symptoms occur. Not surprisingly, we also understand that these pathogens are opportunistic and tend to be most problematic when the plants are already compromised by other stresses such as heat, drought, overwatering, insect infestation, etc. Plant disease diagnostic labs often identify the presence of multiple pathogens in samples with root rot, indicating the complexity within the root environment. When dealing with a root pathogen at any given time, it is critical to implement a comprehensive management plan, including cultural practices and fungicide applications targeting primary and secondary root pathogens that may be compromising plants throughout the season.

Fusarium

Multiple species of *Fusarium* infect chrysanthemum, including *Fusarium* root and crown rot, along with *Fusarium* wilt. *Fusarium* wilt is a serious disease of chrysanthemums caused primarily by the soil-borne fungus *Fusarium oxysporum* f. sp. *chrysanthemi* and related forms. This pathogen invades the plant through the roots, colonizes the vascular tissue, and disrupts water transport, leading to characteristic symptoms and significant crop losses. Wilting leaves, often starting on one side or a single shoot while the rest of the plant appears healthy, are a key diagnostic symptom of this disease.

Fusarium Root and Crown Rot	Fusarium Wilt
Leaves turn yellow, then brown, and may have a scorched appearance. Stunted growth and failure to produce flowers	
Vascular tissue normal	Browning of vascular tissue visible when stems are cut open
Roots discolored, brown or rotted	Roots often appear healthy
Symptoms scattered throughout plant foliage	Symptoms appear on one side of the plant
Sporulation (often pink, salmon or white) at base/crown of plants	

Cultural Controls

- Use disease-free, culture-indexed cuttings and pathogen-free potting media
- Avoid highly susceptible chrysanthemum cultivars; some cultivars show resistance to *Fusarium* wilt
- Maintain soil pH between 6.5 and 7.0, which is less favorable for the fungus
- Avoid ammoniacal nitrogen; use nitrate forms of nitrogen in fertilizers
- Practice strict sanitation: remove and destroy infected plants, clean tools, pots, and remove plant debris

Chemical Control

Timing	Trade Name	Active Ingredient	FRAC	Rate per 100 gal.	REI	Site	Duration
1	Cleary's 3336®	thiophanate methyl	1	8-16 oz.	12 hr.	G, N, L, I, S	21-28 days
2	Chipco® 26019 Flo	iprodione	2	1-2 pints	12 hr.	G, N, L, F	7-14 days
3	Fame®	fluoastrobilin	11	0.15-0.6 fl. oz.	12 hr.	G, N, L, F, S, I	7-28 days
4	Medallion®	fludioxonil	12	2 oz.	12 hr.	G, N, L, I, S, F	7-14 days
Repeat as needed							



Yellowing and dieback are early symptoms of *Fusarium* wilt. Photo by Envu.



Fusarium wilt often causes dieback and death of a section of the plant. Photo by Envu.

Pythium And Phytophthora

Preventative programs, coupled with scouting for early detection of *Pythium*, are critical for successful mum production. Symptoms include root decay and discolored, rotten stems at or near the soil line. Hyphal development may occur under humid conditions, with white to gray webbing visible around the crown. Plants infected later in production often appear stunted and develop slower than healthy plants; leaves appear chlorotic (yellow) and may show signs of nutrient deficiency and wilt, especially during the heat of the day. Plants with *Pythium* root rot will likely not respond to fertilizer and should be examined and tested for the disease. Unpot plants to inspect roots: Infected roots appear discolored (brown to black) and water-soaked. Often when pulling on affected roots, the outer layer (cortex) readily peels away from the root, as opposed to snapping or breaking, and leaves behind a bare strand of tissue. This is only diagnostic of severe root rot. Under favorable disease conditions, *Pythium* can move upward in the plant further rotting the stem and crown.

Phytophthora outbreaks are rare in mum production, often co-occurring with *Pythium*. The recommendations below will manage both pathogens.

Cultural Controls

Pythium is all about water and fertility management. Mums are heavy feeders and it is a challenge to balance fertility, soil EC, and moisture levels while discouraging *Pythium* infection. Maintain soil-less media between 5.8-6.4. Check EC regularly: High EC suggests plants are not taking up fertilizer. Inspect roots. Excess fertilizer or media that contains high soluble salt levels damage roots, causing them to 'leak'. This leakage attracts *Pythium* zoospores, which swim to the roots to infect. Applications to protect newly rooted cuttings, or prior to transplant of liners to pots promotes rapid establishment of plants in the final container. Whenever possible, level low spots and elevate pots to prevent flooded conditions. Heavy summer rains, coupled with high temperatures, create perfect conditions for *Pythium aphanidermatum*; excess water and cooler conditions drive *P. ultimum* infections.

Chemical Control

Week	Trade Name	FRAC Group	Active Ingredient	Rate per 100 gal.	Notes
1	Banol®	28	propamocarb	20-30 fl. oz.	Highly recommended for the prevention of cutting rots of mum and poinsettia. The fire extinguisher for Pythium control. 28 days
5	Subdue Maxx®	4	mefenoxam	1 oz.	Mefenoxam-resistance is a known issue; if symptoms continue to progress, switch to the next fungicide in the rotation. 14-28 days depending upon resistance and disease pressure
7	Terrazole® L Terrazole® WP	14	etridiazole	2.5-7 fl. oz. 3.5-10 oz.	Reliable Pythium control for decades
9	Segway®	21	cyazofamid	1.5-3 fl. oz.	Apply every 14-28 days



Pythium root rot quickly spreads within pots during hot, wet weather. Photo by Envu.



Pythium spreads within and between pots, wherever free water is available to the pathogen.



Pythium also causes significant crown rotting. Photo by Envu.

Rhizoctonia Blight And Root Rot

Rhizoctonia is a soil-borne fungal pathogen notorious for causing problems in mum production. There are multiple *Rhizoctonia* spp. Under warm and humid conditions, the pathogen moves from roots into the crown, causing stem cankers, leaf spots and even aerial blight. Rhizoctonia is a fungus that can infect both living and dead plant tissue, which makes it even more challenging to control.

Cultural Controls

Since *Rhizoctonia* spp. are capable of surviving on non-living substrates, maximize sanitation in production areas of the nursery or greenhouse. Carefully inspect plugs or newly introduced plant material and reject if any symptoms are present. Space plants to allow as much air movement as possible to hasten leaf drying after irrigation or rainfall. Use of HAF (horizontal air flow) fans will increase air movement and reduce overall disease occurrence in greenhouse production.

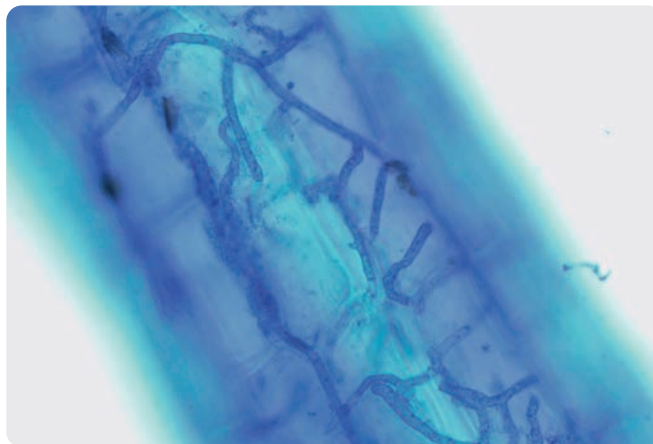
Chemical Control

Applications can be applied to foliage or roots, but ‘sprencing’ provides greatest protection to the crown where Rhizoctonia often gets established.

Timing	Trade Name	Active Ingredient	FRAC	Rate per 100 gal.	REI	Site	Duration
1	Chipco® 26019 Flo	iprodione	2	1-2 pints	12 hr.	G, N, L, F	7-14 days
2	Broadform®	trifloxystrobin + fluopyram	11 + 7	1-2 oz.	12 hr.	G, N, L, F	7-14 days
3	Affirm®	polyoxin d	19	4-8 oz.	4 hr.	G, S	7-10 days
Repeat as needed							



Rhizoctonia root rot. Microscopic examination is necessary to diagnose root rots and identify the appropriate fungicides needed to manage the problem. Photo by Envu.



Rhizoctonia spp. infects multiple plants, including chrysanthemum. The dark hyphae that branch at 90 degree angles are a key diagnostic sign. Photo by Envu.

Foliar Disease

Bacterial Disease

Chrysanthemums are host to a number of bacterial diseases. Bacterial leaf spot, caused by *Pseudomonas cichorii*, produces large, water-soaked lesions on the foliage and/or stems. Lesions are often tan to brown, irregularly shaped and may have a yellow halo. As the infection spreads, veins become dark and discolored; plants may wilt. Symptoms appear in late July through early September, when the weather is both hot and wet. *Pseudomonas* will also infect flower buds.

Another bacterium, *Xanthomonas spp.*, produces small, round leaf spots (2-3 mm). This disease can become systemic, resulting in a blighted stem with blackened vascular tissue.

Cultural Controls

- Anything that reduces free moisture in the plant canopy reduces disease
- Minimize handling of plants and quickly remove and destroy symptomatic plants before bacteria spread through wind-splashed rain or irrigation

Chemical Control

Keeping plants dry is more important than foliar applications to reduce the spread of disease. Infected plants cannot be 'cured'.

Application	Trade Name	FRAC CODE	Rate per 100 gal.	REI	Notes
1	Rhapsody®	B	4-8 fl. oz.	12 hr.	Can be effective when applied preventatively
2	Camelot®	M1	8 fl. oz.	24 hr.	Multiple copper compounds are labeled for control. Greater efficacy (and phytotoxicity) is often found with higher rates of elemental copper. Do not apply B-Nine within 7 days of a copper application
	Phyton® 27	M1	50 fl. oz.	12 hr.	
3	Junction®	M1 + M3	2-3 lb.	24 hr.	Copper + mancozeb. Substitute instead of 2 (above)
4	KleenGrow®	M	6-12 fl. oz.	48 hr.	Quaternary ammonia



Bacterial soft rot on mum. Photo by Dr. Tom Creswell.

Botrytis

Gray mold, or Botrytis blight, is one of the most destructive and economically important diseases affecting mums. The disease is prevalent in both greenhouse and outdoor plantings including shade houses and open field nurseries during or following cool, damp and cloudy conditions where airflow is poor. *Botrytis cinerea* is a fungus that can infect living plant material and persist as a saprophyte on debris, which makes it one of the more challenging plant pathogens to control. It can invade and damage almost any part of the plant, but blight mostly occurs on more tender plant tissues including flowers, buds and leaves with weakened and damaged tissue being most susceptible. Botrytis can quickly invade damaged plant tissue including freshly cut tissue from pruning and propagation, resulting in stem lesions, dieback and decreased rooting of cuttings. Infected tissue appears wet and turns tan to brown. Young fuzzy sporulation appears white to light gray and eventually turns entirely gray.

Cultural Controls

- Anything to reduce humidity and improve air flow will reduce Botrytis, but options are limited with field grown plants.
- Space plants and minimize overhead watering, if possible.
- For greenhouse grown plants, reducing humidity, venting greenhouse, increasing air flow via fans, use of drip irrigation, and spacing plants creates a less Botrytis-hospitable environment.

Chemical Control

Botrytis spp. are the most difficult fungi to control. Not surprisingly, fungicide resistance has been found to all chemical classes. This rotation provides six different modes of action, to better manage both Botrytis and fungicide resistance.

Timing	Trade Name	Active Ingredient	FRAC	Rate per 100 gal.	REI	Site	Duration
1	Chipco® 26019 Flo	iprodione	2	1-2 pints	12 hr.	G, N, L, F	7-14 days
2	Broadform®	trifloxystrobin + fluopyram	11 + 7	1-2 oz.	12 hr.	G, N, L, F	14 days
3	Affirm®	polyoxin d	19	4-8 oz.	4 hr.	G, S	7-10 days
4	Broadform®	trifloxystrobin + fluopyram	11 + 7	1-2 oz.	12 hr.	G, N, L, F	14 days
5	Decree®	fenhexamid	17	1.5 lb.	12 hr.	G	7-14 days
6	Broadform®	trifloxystrobin + fluopyram	11 + 7	1-2 oz.	12 hr.	G, N, L, F, I	14 days
7	Medallion®	fludioxonil	12	2-4 oz.	12 hr.	G, N, L, F, I	7-14 days
Repeat as needed							



Botrytis often begins the infection process by attacking flowers.
Photo by Dr. Jay Pscheidt, ORSU.



Botrytis infection spreads from fallen petals and leaves into healthy tissue, blighting plants. Photo by Dr. Jay Pscheidt, ORSU.

Leaf Spots And Rust

Leaf spots are caused by multiple genera of fungi. Some common fungal leaf spot diseases of chrysanthemum include Septoria, Cercospora, Alternaria and Didymella (Phoma—formerly called Ascochyta ray blight).

Chrysanthemum is host to two rust diseases, brown rust (*Puccinia chrysanthemi*) and white rust (*P. horiana*). When viewed from above, both brown and white rust cause yellow spotting on the upper leaf surface. However, brown rust forms chocolate brown spore-producing pustules usually on the underside of infected leaves. White rust forms white to buff or even pink pustules on the leaf underside.

Leaves are the primary source of infection, with a single leaf supporting numerous spore-filled pustules. In severe infections, pustules may be found on the stems of leaves (petioles) and flower (peduncles), as well as both green and woody branches. Defoliation may occur, and severe infection may reduce plant vigor or even cause plant death.

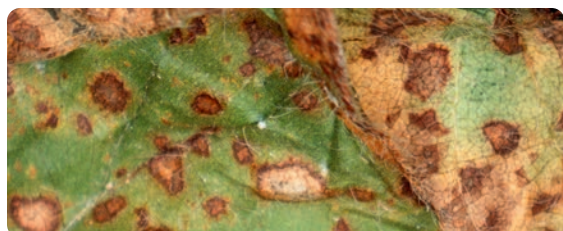
Cultural Controls

Anything that reduces foliar wetness will reduce leaf spot incidence (e.g., drip irrigation). Some mum varieties are reported to be resistant to certain foliar diseases (e.g., Intrinsa®).

Chemical Control

Table 1: Fungicides: The following products are recommended for control of leaf spots and rust diseases. The addition of a spreader-sticker will improve coverage and efficacy.

Trade Name ¹	FRAC CODE	Rate per 100 gal.	REI	Notes
Broadform®	7 + 11	4-8	12	Begin applications at the earliest signs of symptoms. Reapply every 14 days
Eagle®	3	8	24	Choice of FRAC 3 is based upon acceptable REI and cost. Reapply every 14 days
Avelyo®	3	8-10	12	
Torque®	3	8-10	12	



Cercospora leaf spot. Photo by Envu.



Cercospora sporulation is difficult to observe on cultivars with hairy leaves, but can be seen on the tip. Photo by Envu.



Septoria leaf spot. Photo by Dr. Gary Moorman, PSU.



Brown rust, with concentric rings. Photo by Dr. Margery Daughtrey, Cornell University.



Chrysanthemum white rust, with lighter colored pustules. Photo by Karen Snover-Cliff, Cornell University.

Solutions for Insect Management

Aphids

Chrysanthemum aphids (*Macrosiphoniella sanborni*) are typically brown to black and only feed on mums. Fourteen other species of aphids have been reported to feed on mums in North America, including polyphagous aphids like the black bean aphid, melon/cotton aphid, and green peach aphid. Aphids damage chrysanthemums by piercing plant tissues and sucking out the sap, with a preference for new growth such as shoots, leaf undersides, buds, and flowers. Their feeding can cause distorted growth, stunted development, and, in severe cases, the death of the entire plant. As they feed, aphids excrete a sugary substance called honeydew, which attracts sooty mold fungi and leads to the development of unsightly, dark fungal patches. Beyond the physical damage, all aphids are also capable of transmitting various plant viruses.

Cultural Controls

Identify and closely monitor plants known to host high populations of aphids, because infestations will likely start on the most susceptible plants. Frequent inspection of plant material is essential to prevent the rapid buildup of aphids in nurseries and greenhouses. This includes thorough inspection of new plant material for aphids (and other pests and diseases) prior to moving into production areas. Many weeds are hosts for aphids and should be removed or controlled with herbicides. Minimize plant disposal sites and remove escaped plants and weeds under benches, outside greenhouses, or adjacent to nursery stock to reduce the likelihood of aphid infestations in growing areas.

Chemical Control

The Insecticide Resistance Action Committee (IRAC) codes the mode of action of insecticides to facilitate proper rotation across chemical families. IRAC codes make proper insecticide rotation easy to reduce the threat of resistance.

Week	Trade Name ¹	IRAC Code	Rate	Activity	REI	Notes
1	Aria®	29	Foliar or Drench 0.7-2.1 fl. oz.	Contact, Systemic, Translaminar	12 hr.	Apply every 7-28 days. For improved knockdown of heavy infestations, apply as a tank mix with Talstar Select or other fast acting material
3	Kontos®	23	Foliar or Drench 1.7-3.4 fl. oz.	Systemic, Translaminar	24 hr. foliar 0 hr. drench	Apply when pests first appear or when damage is first noticed. Spray thoroughly. The addition of a spreader sticker may improve efficacy
7	Altus®	4D	Foliar 7-10.5 fl. oz. Drench 3.7 fl. oz.	Systemic, Translaminar	4 hr.*	Apply treatment when pests are first detected. Use lower rate for light infestation and the higher rate for heavy infestation
9	Ventigra®	9D	Foliar 1.4 oz.	Translaminar	12 hr.	Do not use as a rescue treatment

Follow all label directions and local recommendations. *The REI is 12 hours in the state of California.



Chrysanthemum aphid adult and nymphs. Photo courtesy of Bugwood.



Aphids vector multiple viruses, capable of infecting mums. Photo by Envu.

Caterpillars

Caterpillars are the larval stage of butterflies and moths (Lepidopteran). Common caterpillar pests of mums include European corn borer, beet armyworm and corn earworm. The European pepper moth (EPM), an exotic invasive, is becoming increasingly problematic in nurseries and greenhouses.

Caterpillar damage increases with the age of the larva, with younger instar caterpillars chewing small holes in the foliage or petals. As caterpillars grow, larger holes or entire leaves are consumed. Defoliation isn't the only problem caused by caterpillars: The European corn borer bores into the stems. Feeding by the European pepper moth results in girdling the stems at the crown, resulting in wilting and collapse of infested plants. Caterpillar damage creates wounds that provide entry for opportunistic pathogens like Botrytis or Pythium.

Cultural controls

Infestations begin with butterflies and/or moths flying into the greenhouse or nursery area. Excluding them with fine-mesh screens is the best way to prevent infestations from occurring. European pepper moth has proven to be a challenge wherever it has gotten established and preventing establishment is key. Sticky traps can be used to monitor adult moth activity. Minimize lights at night, which attracts moths. Weed management, particularly flowering weeds, in and around the production area, discourages new adults from flying in.

Application	Solution	IRAC Group	REI	Rate per 100 gal.	Application Interval	Application Notes
1	Talstar® Pro	3	12 h.	5.4-10.8 fl. oz. ¹	7-14 days	Apply at the first sign of larval emergence in the spring as a knock down. Greater efficacy is observed against smaller caterpillars
2	Durentis™	28	4 h.	2.5-5.0 fl. oz. foliar or drench	28 days	Apply at the first sign of larval emergence in the spring. Apply as a spreng to ensure thorough coverage of foliage while also allowing for product to be absorbed by the roots for additional systemic activity
3	Conserve®	5	4 h.	6 fl. oz.	-14 days	Controls both orders of leafminers and sawflies. Uniform coverage is critical for effective insect control; best efficacy on 2 nd -4 th stage instars
4	Dipel®	11	4 h.	1.5-2 lb.	7 days	Biological insecticide. Resistance reported in a number of caterpillar species

Follow all label directions and local recommendations.



Fall armyworm feeding on chrysanthemum. Photo courtesy of Bugwood.



Fall armyworm, adult male. Photo by John Obermeyer, Purdue University.



European pepper moth caterpillars bore into the crown of mums. Photo courtesy of MSU.

Leafminers

Leafminers are insect larvae that feed within leaf tissue, creating serpentine damage or blotches on leaves. Leafminers are represented by two different insect orders: Diptera (flies) and Lepidoptera (moths). Lepidopteran leaf miners can be distinguished by the presence of a head capsule on the larvae.

Chrysanthemum leafminer (*Chromatomyia syngenesiae*) is the larval stage of flies, approximately ⅛-inch long. Upon hatching, creamy, legless larvae (maggots) penetrate the leaf cuticle and feed within the leaf, creating winding, serpentine trails. Black dots of waste products (frass) are visible in some of the trails. Severely infested leaves may droop, dry and shrivel.

On nursery-grown plants there are often two generations per year. Damage occurs in early summer and late summer- early autumn.

Application	Solution	IRAC Group	REI	Rate per 100 gal.	Application Interval	Insect stage controlled/Application Notes
1	Talstar® Select Talstar® Pro	3	12 h.	20-40 fl. oz. ¹ 21.7-43.5 fl. oz.	7-14 days	Controls adults in both orders of leafminers. Apply at the first sign of larval emergence in the spring as a knock down. Greater efficacy is observed against smaller larvae
2	Conserve®	5	4 h.	6 fl. oz.	~14 days	Controls adults in both orders of leafminers and sawflies. Uniform coverage is critical for effective insect control; best efficacy on 2 nd -4 th stage instars
3	Durentis™	28	4 h.	Foliar 2-8 fl. oz. Drench 8-12 fl. oz.	7-14 days	Apply at the first sign of larval emergence in the spring. Alternatively, apply as a sprench to ensure thorough coverage of foliage while also allowing for root absorption for additional systemic activity
4	Adept®	15	12 h.	4-8 fl. oz. (4-8 bags)	7 days	Controls adult lepidopterous leaf miners only!
¹ Apply lower rates for more juvenile stages (2 nd instar) of instars						

Follow all label directions and local recommendations.



Chrysanthemum leaf miner. Photo courtesy of Bugwood.



Serpentine leaf miner is a common pest of mums. Photo courtesy of Bugwood.

Spider Mites

Spider mites are the most common mites affecting ornamental plants in greenhouses and nurseries. Adult spider mites have eight legs and piercing-sucking mouthparts used to suck fluids from host plants. Most mites damage plants by sucking cell contents from leaf tissue. The initial feeding damage appears as a stippling of tiny dots on the surface of affected leaves. Heavily infested leaves and branches may be covered in fine silken webbing, but webbing may be minimal on some plants. All mites are capable of multiplying rapidly with generations occurring within one week.

Cultural Controls

Adequate irrigation is essential to minimizing drought stress. Dusty conditions drive spider mite populations—apply water to minimize dust from nearby lanes and roads. Overhead watering will reduce spider mite populations, but may create foliar disease problems. Regular scouting, checking the undersides of leaves for damage and/or webbing, and occasional tap tests with a paper plate, aid in early detection of spider mites—and better control if miticides are needed.

Chemical Control

Timing	Treatment	IRAC Group	Activity	REI*	Rate per 100 gal.	Applications Intervals
1	Floramite®	20D	Contact	12 h.	foliar 4-8 fl. oz.	28 days; do not exceed 2 applications per crop
2	Savate®	23	Translaminar	12 h.	foliar 1-4 fl. oz. OR	Reactive. Apply when spider mite populations are high; 14-28 days. Will also control whitefly infestations
	Kontos®		Systemic	24 h. None	foliar 1.7 fl. oz. – 3.4 fl. oz. drench see label	Preventative. 14-28 days. To control mites AND sucking pests like aphids, scale, and mealybugs. 28 + days
3	Akari® 5SC	21A	Contact	12 h.	foliar 16-24 fl. oz.	Do not make more than 2 applications per crop
4	Sultan®	25	Contact	12 h.	foliar 13.7 fl. oz.	14 days; do not exceed 2 applications per crop

Follow all label directions and local recommendations.



Spider mite infestation. Photo by Dr. Roberto Lopez, MSU.



Weeds provide refuge for both insect pests and spider mites. Photo by Envu.

Thrips

Thrips are among the most common and difficult insect pests to manage in commercial mum production. Thrips are tiny (1/16 to 1/8 inch long) and vary in color from yellow to brown to black. Both adults and larval stages feed on plant tissue with rasping-sucking mouthparts. Most thrips feed on leaf tissue but some species can damage young flower buds causing them not to open or be deformed. In addition to this direct damage, thrips are capable of transmitting plant viruses making thrips management critical in commercial production setting. There are multiple genera and species of thrips, but western flower thrips (*Frankliniella* spp.) is one of the most commonly encountered in mum production. Finally, the thrips life cycle is ~14 days. If making weekly applications, do not apply a product more than twice. Ideally, rotate through a program before repeating an application. In this way, any resistant thrips are killed by the next insecticide with a unique MOA.

Foliar sprays are the primary method of protecting flowers, and protection is limited to those flowers that are open at the time of application. Repeated foliar applications are necessary to protect flowers throughout the production cycle. An application of Captiva Prime® at 1-2 pints per 100 gallons, 20-30 minutes prior to an application of contact insecticide (Hachi-Hachi, Conserve, etc.) will drive thrips from buds, leaving them more exposed to contact insecticides, resulting in better efficacy.

Application	Solution ¹	IRAC Group	Activity	REI	Rate per 100 gal.	Application Intervals
1	Kontos®	23	Systemic	none	drench 3.4 fl. oz.	Drench early as a preventative; 14-28 days
2	Hachi-Hachi® SC	21A	Contact	12 hr.	foliar 14-32 fl. oz.	Do not use on impatiens, New Guinea impatiens, <i>Gypsophila</i> spp., and <i>Salvia</i> spp.
3	Aria®	29	Systemic & Translaminar	4 hr. ²	foliar 2.1-2.9 oz.	Best management achieved with application on foliage when insects first appear
4	Conserve®	5	Contact	4 hr.	foliar 6.0 fl. oz.	Do not exceed 2 applications per crop
5-Green-house only	Pylon®	13	Contact	12 hr.	foliar 5.2-10 fl. oz.	5-7 days; do not exceed 2 applications per crop. Greenhouse only
6	Mainspring	28	Systemic, Translaminar	4 hr.	8 fl. oz. foliar or drench	For finishing thrips control and protection against other sucking pests and caterpillars

Follow all label directions and local recommendations.



Thrips damage to flowers. Photo by Envu.



Western flower thrips feeding and damage. Photo by Envu.

Whiteflies

Whiteflies are tiny, sap-sucking insects that can be major pests of chrysanthemums. They are most common during periods of warm to hot weather. When actively feeding, whiteflies cause leaves to turn yellow and eventually brown as the leaf tissue dies. Large colonies typically develop on the undersides of leaves where they normally lay tiny oblong eggs that range from white to yellow, darkening as they age. After the eggs hatch, the young whiteflies go through four nymphal stages called instars. All stages feed by sucking plant juices from leaves and excrete excess liquid as drops of honeydew.

Cultural Controls

Monitor and scout mums regularly. Many weeds are susceptible hosts for whiteflies and should be removed or controlled with herbicides. Yellow sticky traps can be used to aid in monitoring whiteflies and, under high populations even help to reduce their numbers. The use of biological controls (live predators) can be effective but may limit the use of some chemical insecticides.

Chemical Control

Application	Trade Name¹	IRAC CODE	Application Method	Rate per 100 gal.	REI	Notes
1	Reactive: Savate® OR	23	Spray	2-4 fl. oz.	12 hrs.	When whiteflies are established. Will also control mites. 14-28 days
1	Preventative: Kontos®		Drench*	3.4 fl. oz.	0 hrs.	Apply with enough water to moisten media but not flow through container. Will also control mites. 28 days
			Spray	1.7 to 3.4 fl. oz.	24 hrs.	14- to 28-day intervals. Will also control mites
2	Altus®	4D	Spray	10.5-14 fl. oz.	4* hrs.	Contact and systemic, 14-28 day control; extended control with drench application
			Drench	2.8-3.7 fl. oz.		
3	Talus®	16	Spray	6.0 fl. oz.	12 hrs.	Insect growth regulator (IGR) that prevents molting
4	Aria®	29	Spray	2.0 to 4.0 fl. oz.	12 hrs.	Reapply every 7-28 days, as needed
			Drench	2.9-4.3 oz.	12 hrs.	

Follow all label directions and local recommendations. *The REI is 12 hours in the state of California.



Whitefly nymphs and adult. Photo by Envu/Bayer.

Plant Growth Regulators

Height Control

B-Nine foliar spray applications control height, produces darker, greener leaves and stronger stems. Cultivar differences exist between mum varieties. Consider small trials prior to widespread application to identify those cultivars that are highly susceptible to highly resistant to B-Nine or other plant growth regulators (PGRs).

- Apply 2,500-5,000 ppm when new growth is 1-2 in. long, to promote strong growth and reduce stretch.
- A second application can be made 2 weeks later. Use B-Nine to delay flowering. Weekly application of B-Nine up to color break will delay the flowering by 1 week.
- In greenhouse-forced summer crops, apply at 5,000 ppm, 14-21 days after pinching, to control more vigorous varieties.

Keep your mum crop on schedule!

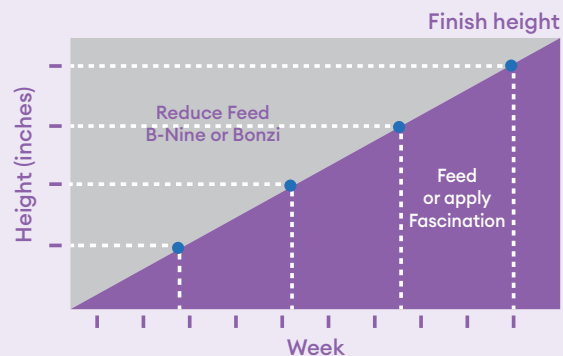
Beginning with rooted cuttings, measure 5-6 plants. This is time zero. Identify where you want the height of the final crop to be at finish. Each week, measure 5-6 plants and plot their growth (Figure below). If they are above the line, apply B-Nine to reduce height, while reducing feeding. If they are below the line, increase fertilizer or consider an application of Fascination.

GROW TIP

Track Your Crop

It is important to keep your crop on schedule. Fortunately, mums are an easy crop to track. Graph a straight line between initial plant height and desired height at finish. Each week, measure 5 plants in the primary block.

- If they are below the line, feed them or use Fascination.
- If they are above the line, use a PGR to slow them down.



Solutions for Weed Management

As spring sales wrap up, the garden mum growing season shifts into high gear. Now is the ideal time to ensure your field is fully prepared before planting your garden mums. Proper preparation sets the stage for a strong, healthy start.

Begin with a level field to prevent the occurrence of puddling in low-lying areas (from rain or irrigation), thereby minimizing risk of root rot and other diseases. If leveling isn't possible, consider raising pots on trays in these spots to reduce potential root rot issues. Cover the field with ground fabric that allows water to pass through while preventing weed growth. Fabrics with printed lines help maintain tidy, evenly spaced rows. Clear the ground cover of any weeds or debris to eliminate potential sources of disease from the previous season. Weed control is a

considerable pest management expense whether you grow in a nursery or a greenhouse. Experts estimate the overall cost of weed control in a container nursery can be more than \$6,000 per acre, including application labor, chemical costs and other weed maintenance costs over the life of a crop (Mather, unpublished). These costs do not factor in that weeds serve as reservoirs for insect pests, many of which vector viruses and other plant pathogens!

Preemergence herbicides like Marengo Flo and Marengo G are the most cost-effective way to control weeds. All preemergence herbicides should be used carefully, and per label instructions whether applied in a greenhouse or a nursery.

Recommendations for best results:

- Apply prior to shifting mums to outdoor growing operation.
- After treating area, activate Marengo by watering in with light irrigation (0.25 inch) prior to weed germination.
- Growers are recommended to wait until Marengo treated areas have been watered in and allowed to completely dry before plants are placed in direct contact with an area treated with Marengo.
- Do not allow Marengo to puddle or pool, especially where potted plants will be placed.
- At end of mum season, rotate with another product with a distinct mode of action (e.g., flumioxazin).



Raising pots, particularly in low spots, minimizes the risk of root rots. Photo by Envu.



Spacing, weed management and good drainage are important cultural controls for successful mum production.

Treatment	Rate per Acre	Rate per 1000 sq. ft	Notes
Marengo® Flo	7.5-15.5 fl. oz./A	0.17-0.36 fl. oz. per 1,000 sq. ft.	
Marengo® G	200 lb.	4.6 lb. per 1,000 sq. ft.	

At the end of season (prior to winter annual weed seed emergence), rotate to a new mode of action. If winter annual weed seeds have emerged, burn down with an application of glyphosate or glufosinate to prevent seedling establishment. Follow with the suggested pre-emergent herbicide rotation partners including, but not limited to:

Liquid herbicide (WSSA Code)	Granular herbicide
SureGuard® (14)	BroadStar (14)
Tower® + Barricade® (15 + 3)	Freehand® 175G (3 + 15)
Tower + Dimension® (15 + 23)	Snapshot (3 + 29)
Gallery® (21)	

Chrysanthemum Calendar

Chrysanthemum Cutting Establishment Agronomic Program

Day	Problem	Solution (XRAC Code)	Rate	Notes
0	Sticking/Establishment	Stick in well-drained soilless media (4 on a 1-5 scale) with soil pH of 5.8-6.2; EC of less than 1.0 (mmhos/cm. SME). Maintain media temperature between 70° to 74°F (21° to 23°C) using bottom heat to accelerate rooting		
3	Botrytis, Rhizoctonia, Fusarium	Chipco 26019 (FRAC 2)	1-2.5 qt. (32-80 oz.)	For Botrytis, Rhizoctonia and Fusarium protection, every 7-14 days
7	Stretch	B-Nine (PGR Mode 1)	1,000 to 2,500 ppm	To reduce stretch; an additional application may be made on Day 14. Do not apply copper within 14 days of a B-Nine application
10	Botrytis, Rhizoctonia	Broadform (FRAC 7 + 11)	4-8 fl. oz.	Sprench for optimal protection
14	Fungus gnats, shore flies	Adept (IRAC 15)	2 oz.	Sprench to control fungus gnats and shore flies that can cause significant root damage and provide infection courts for Fusarium, Pythium and Rhizoctonia. 30-60 days of control
21	Botrytis, Rhizoctonia	Chipco 26019 (FRAC 2)	1-2.5 qt. (32-80 oz.)	For Botrytis, Rhizoctonia and Fusarium protection, every 7-14 days
28	Aphids, whiteflies, mites	Kontos (IRAC 23)	1.7-3.4 fl. oz.	Sprench to protect cuttings after roots are established

Treat nursery or greenhouse areas with Marengo pre-emergent herbicide prior to planting if not already treated. A full application (Marengo Flo=15.5 fl. oz.; Marengo G=200 lb.) will provide 12+ weeks of control, protecting against weed establishment for the entire cropping cycle. Split applications will provide even longer protection.

Transplant

Scout regularly, applying pesticides only when needed. These are suggested timings only, use local weather to optimize applications; charts highlight periods of typical pest and disease activity. Suggested treatments were chosen to treat multiple problems simultaneously. Always read and follow label instructions carefully.

Weeks to apply protected	Problem	Trade Name	Rate per 100 gal.	Notes
0	Pythium root rot	Banol (FRAC 28) or Terrazole L (FRAC 14) Terrazole WP (drench only)	Drench 20 oz. 2.5-7 fl. oz. 3.5-10 oz.	Prior to transplant, treat fertilized liners or dip plants to prevent Pythium root rot. Drench tip: To improve fungicide penetration, follow with an additional quantity of water equal to at least half the volume of the fungicidal drench, applied either by sprinkling or irrigation. Will also protect against Phytophthora
2-5	Aphids, whiteflies, thrips suppression	Altus (IRAC 4D)	Sprench 7-14 fl. oz.	Lower rates for aphids, higher rates for thrips and whiteflies
3-5	Botrytis, leaf spots, rust Rhizoctonia	Broadform (FRAC 7 + 11)	Sprench 4-8 fl. oz.	Be sure to spray crown and undersides of leaves to improve coverage
4-8	Leaf miners, armyworms, EPM, aphids	Durentis (IRAC 28)	Foliar 2-8 fl. oz. Drench 8-12 fl. oz.	If needed
4-7	Pythium	Segway (FRAC 21)	Sprench 3 fl. oz.	Will protect against Phytophthora too
5-8	Aphids, whiteflies, thrips suppression	Aria (IRAC 29)	Sprench 0.7-4.3 oz.	Lower rates for aphids, higher rates for thrips and whiteflies 7-28 days protection

Weeks to apply protected	Problem	Trade Name	Rate per 100 gal.	Notes
6-8	Leaf spots, rust	Avelyo (FRAC 3)	Foliar 8 fl. oz.	When scouting, observe lowest and internal leaves. Add Decree (FRAC 17) or Affirm (FRAC 19) if additional Botrytis protection is needed at this time
		Eagle (FRAC 3)	8-10 fl. oz.	
		Torque (FRAC 3)	8-10 fl. oz.	
7-10	Spider mites	Floramite (IRAC 20D)	Foliar 4-8 oz.	Begin scouting as temperatures increase. Examine undersides of leaves with hand lens. Use 4 fl. oz. per 100 gal. of water for preventative applications or where mite infestations are light. Up to 8 fl. oz. per 100 gal. of water may be required for heavy infestations or for extended residual control. Maintain spray mixtures within a range of pH 5.5 to 6.5. Addition of a spreader will improve coverage and efficacy
7-11	Pythium root rot and Fusarium, Rhizoctonia	Terrazole L	Drench 2.5-7 fl. oz.	Continue protection against root rots especially if conditions turn warm and wet
		Terrazole WP (FRAC 14 PLUS)	3.5-10 oz.	
		Fame (FRAC 11)	Sprenc 1-2 fl. oz.	
8-9	Thrips, armyworms, EPM, aphids, whitefly, suppression	Hachi-Hachi (IRAC 21A)	Foliar 21-32 fl. oz.	Switch to Conserve if leafminers are presenting a problem
8-10	Leaf spots, rust	Broadform (FRAC 7 + 11)	Foliar 4-8 oz.	Add spreader to improve coverage
10-12	Leafminers, armyworms, EPM, thrips, spider mites	Conserve (IRAC 5)	Foliar 22 fl. oz.	Spray to penetrate dense foliage, but avoid overspraying to the point of excessive runoff. Uniform coverage of entire leaf surfaces is critical for effective insect control
11-12	Pythium Root Rots, Fusarium, Rhizoctonia	Segway (FRAC 21) PLUS Chipco 26019 (FRAC 2)	Sprenc 3 fl. oz. PLUS 1-2.5 qt.	Treat earlier if pressure is high, extend interval under lower disease pressures
12	Leafminers, armyworms	Durentis (IRAC 28)	Sprenc 0.7-5.3 fl. oz.	Sprencing will target foliar feeding insects while providing systemic control as well for 14-28 days. Takes about 2 weeks to translocate throughout plant
12-13	Leaf spots, rust. Begin scouting, looking at lowest and internal leaves	Avelyo (FRAC 3)	Foliar 8 fl. oz.	Add spreader to improve coverage
		Eagle (FRAC 3)	8-10 fl. oz.	
		Torque (FRAC 3)	8-10 fl. oz.	
13	Spider mites	TetraSan (IRAC 10B) or Sultan (IRAC 25)	Foliar 8-16 oz. Foliar 13.7 oz.	Addition of a spreader will improve coverage and efficacy
14-16 +	Aphids, whiteflies, thrips suppression + mites	Kontos (IRAC 23)	Sprenc 1.7-3.4 fl. oz.	Finishing spray providing protection for up to 4 weeks
15	Leaf spots, rust. Begin scouting, looking at lowest and internal leaves	Broadform (FRAC 7+11)	Foliar 4-8 fl. oz.	Add spreader to improve coverage

At the end of season after mums have shipped but prior to winter annual weed seed emergence, rotate to a new mode of action. If winter annual weed seeds have emerged, burn down with an application of glyphosate or glufosinate to prevent seedling establishment. Follow with suggested rotation partners including, but not limited to SureGuard or BroadStar (WSSA 14) Freehand (WSSA 3 + 15) or Tower+Barricade (WSSA 15 + 3).



**Together we built a legacy,
now let's build the future.**

For more information, contact your local Envu representative or visit: www.us.envu.com



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