
Commercial Specialty Cut Flower Production

GLADIOLUS



The gladiolus has a global history. It (glad) was captivating enough to prompt creation of the American Gladiolus Society in Boston in 1910, and interest continues. Countless species grow throughout the world, from South Africa to the Mediterranean to West Asia.

Glads grow 2–6 feet high, topped by a flower spike bearing a double row of trumpet-shaped florets. The flowers range from 1–8 inches in diameter and may be ruffled and deeply cut, or simple and plain. The plant's sturdy, sword-shaped leaves inspired its name, which comes from the Latin word *gladius*, meaning sword. Colors range from white and yellow to purple, smokey and even green shades. In general, glads are not fragrant.

Low cost and ease of culture are reasons glads are popular today. They are relatively free from insects, have an extremely wide color range and a long blooming season. Also, they increase rapidly and are easy to carry over from year to year. Expert breeders and amateurs have devoted more than a century of hybridizing and selection to modify the plant to the colorful, blossom-laden varieties in demand today.

Glads are the most widely grown outdoor cut flower. Since 1935, greenhouse production has been virtually eliminated because of outdoor winter and spring production. Consumers have responded, finding uses for glads that range from fancy centerpieces to bridal bouquets.

Varieties to Grow

The glads grown in gardens and as cut flower crops belong to *G. x hortulanus*, or garden gladiolus. It is a complex group of hybrids, and the cultivars and colors are too numerous to list here.

Cultural Requirements

Soil. Glads grow best in sandy loam, though almost any soil can be adapted. The key in soil selection is proper drainage; glads do not grow well in soil that is too wet (puddles remain 24 hours after the soil is saturated). Soggy, compacted soil hampers root growth, diverts moisture and locks up plant food. It also contributes to root rot.

To improve drainage, add organic matter such as leaves, spoiled hay, straw, manure or compost in late fall to ground that will be planted with glads the following spring. Raising the beds 3–6 inches will also improve drainage.

The soil should have a pH of 6.0–6.5. Till the soil about 2 weeks before planting.

Planting. Glads grow from corms produced by the storage of food at the base of the leaves. Unlike true bulbs, which are layered, corms are solid masses of tissue and the base of the current year's stem, which grows from the point on the upper surface.

Each year, soon after foliage appears, a new corm develops on top of the old one, which shrivels and dies. Papery husks form around the corm, overlapping and facing the pointed tip. The husks are the bases of old leaves and protect the corm from mechanical injury, insect and disease infection, and water loss. The papery tunic should be left on the corm until just before planting, when it may be removed for treating with fungicides. One or more corms may form on an old corm.

Cormels, little corms, may develop around the base of the corm. Cormels are often used to propagate a glad

cultivar. When planted, they will develop into small corms the following year.

Corms are graded according to seven sizes based on diameter in inches.

Jumbo: 2" and larger

No. 1: 1½" and larger

No. 2: 1¼"—1½"

No. 3: 1"—1¼"

No. 4: ¾"—1"

No. 5: ½"—¾"

No. 6: under ½"

Corms graded Jumbo, 1, 2 and 3 will produce marketable flowers the first year. Grades 4, 5 and 6 will develop to the larger sizes and flower the following year.

Larger corms may flower earlier than smaller corms, with a potential 5-day difference between successive grades. The number of spikes produced per 100 corms and the number of florets per spike increase as the size of the corms increases. The planting of Jumbo or No. 1 grade corms generally will have a competitive advantage in quality of spikes produced.

To prevent disease after planting, treat corms by dusting or dipping in fungicide. Soak the corms according to label instructions for concentration and timing.

Plant when the soil has warmed to a depth of 6 inches or when native deciduous trees begin to leaf out. In Kansas, this is late April to early May. Corms planted in cold soils are apt to rot before they begin to grow.

For cut flower use, plant glads in rows spaced 12–36 inches apart, depending on size of flowers desired, production system—bed or field row—equipment, and space available. The spacing between corms and their depth in the soil will depend on corm size, soil type and quality desired. Generally, space the corms 2–6 inches apart, with large corms 6 inches apart, in trenches or individual holes. Large, show-quality flowers require more space, about two to four times the corm diameter. In light soils, plant large corms 6–7 inches deep. In heavy soils, plant large corms about 4 inches deep. Plant small corms shallower. Deeper planted corms flower later by a few days, but may support the spike with little or no tying. Place corms by hand, pointed side up, then cover mechanically.

Glads exposed to wind may require support to ensure tall, straight flower spikes. When the plants are 8 inches tall, mound the soil around the base. Later, tie glads to wires extended the length of the row, or stake each plant individually. In either method, allow for some movement by the flower spike to prevent damage and breakage.

After the first planting, plant at 1- to 2-week intervals to lengthen the blooming season. Days to bloom can vary from 60–120, depending on the variety and size of corm. Time the last planting to bloom before killing frost. In Kansas, the last planting is generally in late July. With planning, the blooming season can extend for several months

Watering. Kansas growers should not attempt to produce specialty cut flowers without providing supplemental irrigation. The dollar value of the crop and demands of the market are such that it is inadvisable to attempt production under natural rainfall in Kansas.

Overhead watering is not recommended. It may damage the flowers, cause spotting on the petals, splash soil onto the foliage and promote the spread of disease. Drip irrigation is recommended because it places the water on the ground where it is needed, not on the flowers or foliage.

Glads need plenty of water. Lack of water inhibits spike growth, flower development and corm growth. Watering at planting will help develop a good root system, which is especially important on late plantings in warmer weather when top growth is prone to exceed root growth. Water becomes essential when flower spikes begin to form and when florets begin to open. Provide at least one inch of water each week to ensure good growth, making sure the water soaks 6–8 inches into the soil.

The amount and frequency of water required will vary with the weather and stage of maturity of the crop. Base the irrigation schedule on the soil moisture status in the root zone, and irrigate to provide sufficient but not excessive water to the crop. Insufficient water will reduce the production and quality of a crop, whereas a consistently saturated soil will reduce growth and promote development of root rot.

Fertilization. Before initiating any fertilizer program, always test the soil for nutrient content. The increased water requirement of cut flowers creates an increased requirement for fertilization. The application of fertilizer should coincide with crop needs.

Fertilizer can help produce large flowers on glads. Apply at the rate of 1½–2 pounds of actual nitrogen from a 1-1-1 ratio fertilizer per 1,000 square feet of crop. For example, 2 pounds of actual nitrogen would be 10 lbs/1,000 ft² of super phosphate (0-20-0), 5 lbs/1,000 ft² of potassium nitrate (20-0-44), and 3 lbs/1,000 ft² of ammonium nitrate (33-0-0). If following a single application plan, apply a slow-release nitrogen at planting time. If a split application is desired, apply one-third at plant-

ing, one-third at midseason and the balance when flower spikes emerge. Keep fertilizers away from corms and stems to prevent damage to the plants.

Weed Control. Growers must control weeds in glad production, as competition with weeds reduces the quantity and quality of floral production. A bed full of weeds also increases the time required to harvest, raising labor costs. Several options are available to combat weed growth: herbicides, barriers or mulches, and hoeing and hand-weeding.

Due to limited production of many species of specialty cut flowers, only a few herbicides are labeled for use. Treflan and Dacthal are effective preemergence herbicides for use on glads. If weeds are already established, cultivate, hoe or pull them by hand. Other herbicides labeled in 1993 for use on glads are XL (benefin and oryzalin), Ornamec and Fusilade (fluazifop-P-butyl), Betasan (bensulide), Pre-San (benzensulfonamide) and Pennant (metolachlor). Gallery is also labeled for use on glads but should only be used on corms larger than 1 inch in diameter after the shoot has emerged above ground. As always, read the label on all chemicals and apply only as directed.

Weed barriers and mulches prevent weed growth and restrict soil splash on foliage and flowers from rain and irrigation. The greatest benefits in weed control occur early in the growing season while glads are becoming established. Materials such as green hay and sawdust are commonly used in the production of glads. Mulching creates a cooler growing environment that slows growth, lengthens the stem and flowerhead and adds distance between the buds. Mulch also provides a more consistent soil moisture level by reducing evaporation from the soil surface.

While hoeing and hand-weeding are excellent methods of weed control, availability and cost of labor may be prohibitive in all but the smallest production situations.

Insect Control. Good cultural practices are the best insect control. A healthy, actively growing glad is more resilient to insect attack. The ideal approach is a preventive program. Control insects early, when they are first detected; do not wait until a serious infestation occurs. Less chemical can be applied to spots as they develop than would be required to spray the entire crop. Insects affecting glads are thrips, red spider mites, aphids and wireworms.

Thrips, tan to black and $\frac{1}{25}$ inch long, are the major insect pest of glads. They feed on sap from leaves and flowers abraded by their rasping mouthparts, leaving

behind small, silvery flecks. Thrips also injure untreated glad corms in storage. Treat corms with an insecticide before planting and after harvest to prevent thrip infestation. Throughout the season, monitor the glads for thrip infestation and control with insecticides as required.

Red spider mites are reddish-yellow or black and less than $\frac{1}{16}$ inch long. They attack foliage with their sucking mouthparts. Infestation is characterized by grayed foliage and webbing on the plants. Control will normally require three applications of an insecticide spaced about a week apart. Consult label for specific recommendations.

Aphids are visible to the naked eye. They have sucking mouthparts and are most active on the young, growing parts of plants. Infestation is distinguished by crinkled and distorted foliage and leaf buds. Plants may have a sooty appearance. Aphids are also carriers of many viral diseases.

Wireworms injure corms in the field and sometimes eat the roots from other plants. The pest is the larval stage of the click-beetle or snapping beetle. Mature larvae are slender, hard-shelled, dark brown or yellow worms, about 1 inch long. They are most troublesome in soil that is too wet. Control by sterilizing the soil where practical.

Disease Control. Diseases often reduce the quantity and quality of gladiolus flowers, and in some cases, cause significant plant mortality. Diseases such as Botrytis blight, root rots, aster yellows, and storage rots, are perennial, while other diseases may be sporadic. The following table lists some of the more common gladiolus diseases, their symptoms and control. Be careful in using the table. Certain plant diseases are difficult to identify by field symptoms. Be sure to consult a plant pathologist for accurate disease diagnosis before applying any fungicides.

Gladiolus diseases usually can be controlled by a combination of sound cultural management and chemical use. Avoid overhead watering and keep plants adequately spaced for good air circulation. Overcrowding may result in plant losses from Botrytis blight and other fungal and foliar blights. Water the plants early in the day to allow for good foliage drying before nightfall. Closely monitor plants for any signs of diseases or insect activity. Remember that aphids, leafhoppers and thrips may transmit viruses. Keep fields as weed-free as possible to control insects and viruses. Rotate planting beds in the field each year to avoid buildup of soilborne fungal pathogens and nematodes.

Routine fungicide applications may be necessary to control Botrytis blight on susceptible varieties of gladiolus during wet years. Control is much more effective if

Gladiolus Diseases		
Root Rots and Wilts	Symptoms	Control
<i>Fusarium oxysporum</i> f. sp. <i>gladioli</i>	Corm rot. Yellows. Wilt. During the growing season, leaves turn yellow prematurely and stems collapse. During storage, corms develop a reddish-brown dry rot. Diseased corms produce spindly, weak plants the following year.	Rotate to new planting sites each year. Soak cleaned corms for 15–30 minutes in 85–120°F dip of thiophanate-methyl or dip corms in solution of iprodione at ambient temperature. Discard all heavily rotted corms.
<i>Rhizoctonia solani</i>	Dark brown lesions develop on the corm. The foliage turns yellow, and the plant may die.	Treat corms as listed for <i>Fusarium</i> rot. Soil drenches of thiophanate-methyl or iprodione may help prevent continued spread in the field.
<i>Septoria gladioli</i>	Hard rot. Dark brown or black, sunken lesions appear scabby. Corms may mummify. Can develop in storage.	Refer to corm treatment for <i>Fusarium</i> rot.
<i>Stromantina gladioli</i>	Dry rot. Dark brown or black, sunken lesions appear scabby. Corms may mummify. Small, dark sclerotia sometimes present. Plants turn yellow and die prematurely. May develop in storage.	Avoid planting in infected soil. Plant in raised beds. Treat corms as described above. For control of disease outbreaks in the field, apply PCNB at planting.
Root knot nematode <i>Meloidogyne incognita</i>	Stunted growth, yellowing, and wilting of foliage. Gallling on the roots.	Test soils for presence of root knot nematode. Rotate or fumigate soil. Warm water treatment as outlined for <i>Fusarium</i> rot will help disinfect corms. Treat infected fields with oxamyl.
Storage Rots		
<i>Penicillium</i> sp.	In storage, corms develop brown, water-soaked lesions. When humidity is high, masses of blue mold are produced.	Discard damaged or diseased corms. Use a hot water treatment and a fungicide dip as outlined for <i>Fusarium</i> rot.
<i>Botrytis gladiolorum</i>	Infected cut flowers develop water-soaked spots, which turn the whole flower brown and slimy. Corms develop a white mold and are soft and spongy.	Same as for <i>Penicillium</i> sp.
Viruses		
<i>Rhizopus arrhizus</i>	Light brown soft rot on corms.	Same as for <i>Penicillium</i> sp.
Cucumber mosaic virus Tomato ringspot White break mosaic	Virus symptoms are variable and include mottling, mosaics, ringspots, yellowing, distortion, and stunting. Virus identification based on symptoms is difficult and may require assistance from a plant pathologist.	Rogue all virus infected plants, keep fields weed free, and control insect vectors. There are no controls once the plant is infected.

Gladiolus Diseases (*Continued*)

Disease	Symptoms	Control
<i>Botrytis</i> spp.	Small to large, brown spot on leaves and flowers. Grayish fungal growth appears on spots during wet weather.	Fungicide application should begin before flower production to prevent inoculum buildup on leaves. Apply ferbam, maneb, mancozeb, cupric hydroxide, vinclozolin, chlorothalonil, or iprodione at 7- to 14-day intervals as soon as leaf spotting occurs and continue through harvest. Remove damaged flowers from field during harvest.
<i>Curvularia</i> spp.	Tan to dark brown, oval spots surrounded by a yellow halo on leaves and stems. Under humid conditions, lesions develop a dark, smudgy appearance. Florets fail to open when petioles are girdled.	Crop rotation. Apply maneb, mancozeb, or chlorothalonil at first signs of disease and continue at 7- to 14-day intervals.
<i>Septoria gladioli</i>	Brown to purplish-brown, circular leaf spots.	Crop rotation. Apply maneb, mancozeb, or chlorothalonil at first signs of disease and continue at 7- to 14-day intervals.
<i>Stemphylium</i> sp.	Small, round, reddish-brown spots with translucent to yellow margins on leaves and stems. Small corms may develop if foliage dies before flowering or after spikes are harvested.	Crop rotation. Apply maneb, mancozeb, or chlorothalonil at first signs of disease and continue at 7- to 14-day intervals.
Bacterial blight <i>Xanthomonas campestris</i> pv. <i>gummisudans</i>	Narrow, rectangular leaf spots. Initially dark green, leaf spots turn brown. Entire leaves may scorch. Bacterial exudate or ooze is frequently present at lesion. Wet weather disease.	Keep foliage dry and avoid working on wet plants. Fungicides not effective.

fungicides are applied before symptoms of Botrytis blight are apparent. Other fungal diseases may be controlled by curative fungicide applications beginning as soon as symptoms develop. Don't wait until plants are severely blighted to start applying fungicides. The table above lists fungicides currently labeled for control of specific diseases. Be sure to diagnose the disease correctly and follow all instructions on the fungicide label.

Most of the diseases that affect glads can be controlled by selecting good planting sites and using clean corms. Follow the procedures outlined in the corm storage section to ensure a disease-free crop.

Corm storage. Lift and store glad corms each fall to prevent diseases from developing while corms are in the ground. Corms are ready for digging 6–8 weeks after

blooming or when foliage begins to yellow and die back. If the tops are still healthy, delay digging to add corm development, but make sure corms are dug before the first hard freeze. Corms that are dug too early will succumb to storage breakdown faster than those that have matured.

Dig corms when the soil is dry to make digging and cleaning easier. Break up the soil with a spade or digging fork and pull the plants by hand. Shake off loose soil. If the cormels are needed for future propagation, dig corms carefully and group by varieties immediately. Break off the plant as close to the corm as possible. Doing this by hand, rather than using shears or scissors, will leave a small hole in the husk on the top of the corm and allow moisture to escape faster in the drying process.

Put corms in a light, warm, airy place for 2–3 weeks to cure. It is important to dry corms as rapidly as possible to help prevent storage breakdown.

During drying time, a cork layer forms between the new corm and the old corm and roots. After the corms are cured, snap off the old corm by hand and discard it. This will leave a clean scar on the new corm. Undue delay in cleaning results in greater difficulty in removal. Remove the loose husks, leaving the wrapper husks intact. Also remove the small cormels and place in a labeled paper bag for winter storage.

Dust corms with an insecticide labeled for thrip control. Discard all diseased corms and place the rest in uncovered trays with screen or slat bottoms, arranged to allow air to circulate between them. Place no more than four layers of corms in each tray to prevent heating. Paper bags, mesh onion bags and nylon stockings are also used for winter storage. Keep the varieties labeled and separated because light-colored varieties multiply faster than dark colors.

Store corms in a dark, dry, well-ventilated place, with temperatures between 35–45°F. Before planting the next season, go through the corms again and discard any diseased corms.

Harvest Practices

Gladiolus spikes exhibit negative geotropism. This means that if the floral spikes are laid flat in storage or transport, the tips will curve upward. While Oriental or Eastern design work may call for spikes with natural curves, the market generally prefers straight spikes. Keep spikes upright in the field through use of stakes or supports to prevent the spikes from bending. Use tall containers that hold the stems upright during harvest, handling, packing, storage and transit.

Handling and harvest practices for glads depend on the intended market. Regional, national and international wholesale markets require harvest when the basal (lowest) florets on the spike begin showing color. Local wholesale markets want spikes with more florets showing color and the basal florets partly opened. Local retail markets need the basal florets fully open to display their beauty to the consumer.

Harvest Requirements

- Harvest stems during the cool part of the day—morning or late in the day—when the plants and flowers are free of dew and moisture.
- Harvest spikes according to the maturity required for the intended market.

- Use clean, disinfected harvest containers and cutting utensils.

- Cut stems as long as possible whether they are the standard types or small pixie types.
- Keep at least four leaves on the plant to stimulate corm development.
- Strip excess and damaged foliage from the stems in the field.
- Place newly harvested stems in commercial floral preservative or acidified—pH 3.5 citric acid works well—clean water.
- Remove stems from the field as soon as possible to cold storage or to a cool, shady place until the flowers can be graded and processed.
- Keep the spikes vertical.

Postharvest Practices

The maturity of the spike at harvest will determine its storage time and vase life. Less mature spikes store longer than more mature spikes. Glads harvested with closed florets can be stored upright and dry-wrapped in moisture-proof materials for one week at 36–40°F. This can be beneficial to growers who want to pack glads immediately after harvest and ship them up to a week later. Spikes with closed florets can also be stored upright in preservative for 1–2 weeks. Growers selling to local markets may prefer this storage method. More mature spikes (more open florets) will store a shorter time and have a shorter vase life.

Glads are sensitive to fluoride in holding water. Fluoridated city water contains enough fluoride to damage glads. Because most Kansas growers are in rural areas where rural water is used, fluoride toxicity is usually not a concern. Growers using city water, well or pond water should test their water for fluoride. The city water treatment plant will have information on the fluoride content of city water. If the water is fluoridated, growers should find an alternative water source or check filtering possibilities.

Postharvest Requirements

- Grade by stem length, flower size and cultivar.
- Bunch by buyer's specifications, usually in bunches of 10 spikes.
- Recut stems under water to a uniform length.
- Store graded and bunched stems in clean, disinfected containers in commercial floral preservative.
- Or, store stems upright and dry-wrapped in moisture-proof materials.

- Store at 36–40° F and 85–90 percent relative humidity.

- Keep the stems vertical.

Packaging and Packing. As discussed earlier, glads must be kept upright, even during packaging and packing. Buyers demand it. Local consumers, retail florists and wholesalers selling directly to local retail florists often will accept flowers delivered in buckets of floral preservatives. Glads intended for regional, national and international markets should be packed dry in special gladiolus hampers that keep the spikes upright.

Marketing Information

Identify and organize market strategies before investing in seed, plants or equipment. Knowing how and where to sell the product is crucial to the success of a business. Be flexible and determine more than one outlet; have a backup plan. The goal is to create a successful, profitable and sustainable business, and although definitions of success and profitability may differ, sustainability is the same everywhere.

Gladiolus are marketed fresh. They provide a spike or vertical flower shape for design work.

Market Outlets

Local direct retail markets:

- farmers markets
- roadside markets
- restaurants
- caterers

Local wholesale markets:

- florists
- roadside markets
- grocery stores
- flower brokers

Regional/national/international wholesale markets:

- cooperatives
- flower brokers

Even though there are many marketing options, only large growers are able to service wholesale markets. Large growers have several acres in production and routinely use contract or migrant labor to plant, harvest and handle crops. The competitive market requires close control of production costs, and growers must make up for smaller profit margins by selling large quantities.

Large commercial markets demand consistent, reliable supplies of quality flowers. Growers selling in large commercial markets must pay critical attention to harvesting at the proper maturity, use of preservatives and careful handling to keep the spikes upright. The spikes must be bunched by color and type.

An attractive market for small or new growers is local farmers markets. Glads seem to sell well where fresh local produce is sold directly to the public. They sell best as single stems so consumers can select the color mix they want, although giving the consumer a multiple stem price break—\$1 per stem or six stems for \$5—is a good merchandising tool. It may be beneficial to line price different sizes of glads; small @ \$.50 per stem, medium @ \$.75 per stem, and large @ \$1 per stem. It may also be profitable to tag the bicolors and unusual colors with a premium price.

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