CULTURAL CONCEPTS OF GYPSOPHILA PANICULATA L. PRODUCTION IN FLORIDA

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Abstract. Procedures for successful culture of gypsophila under subtropical climatic conditions are described. Rooted shoot-tip cuttings or grafted plants are used for planting stock. Gypsophila roots are easily damaged by high soil temperatures, anaerobic conditions in waterlogged soils, high soluble salt levels and herbicide residues. Well-drained calcareous soils with loose texture and good aeration are most satisfactory for commercial culture. Major insect and disease problems include leafminers, armyworms, red spider mites and crown gall. Gypsophila plants are dug, top vegetative growth is removed and roots are stored between production seasons. Large losses of stock often result from root desiccation, disease development and excess vegetative growth during storage. Vegetative shoot growth in storage is affected by both moisture content of packing media and temperature. Optimum storage conditions are 35°F with roots packed in a dry media such as peat moss or wood shavings in containers lined with a moisture barrier such as polyethylene film.

Gypsophila is the third largest cut flower crop in Florida with an estimated 100 acres currently in production with an annual value of approximately one million dollars (18). No information is published on commercial culture of this crop in Florida, with only a few reports of disease incidence and various botanical descriptions in print. Research on gypsophila began two years ago at the Agricultural Research and Education Center at Bradenton and information is being accumulated. It is a very difficult crop to research because of plant variability and the nature of flowering which make meaningful yield records difficult to obtain. The following information was assembled from observation of the industry, review of the literature available, and present research data. The information presented herein will be expanded and modified as more is developed for this crop.

Propagation

The perennial white type which comprises almost 100% of the Florida production, Gypsophila paniculata L., can be grown from seed (1, 2, 10, 22) but seedlings are variable in quality and degree of flower doubleness (5, 8) and are generally unsatisfactory for commercial production. ‘Paniculata double white’ and ‘Double Snowflake’ are white double-flowered perennial varieties which can be grown from seed (2). Gypsophila seed germinates best at 65-75°F and seedlings emerge 10-18 days after planting. G. paniculata flowers from seed in four to six months.

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Grafted plants. Commercial production of fully double white G. paniculata ‘Bristol Fairy’ was traditionally based almost entirely on use of grafted plants (17). A ‘Bristol Fairy’ vegetative scion is grafted to a root of ordinary single G. paniculata. This graft produces a vigorous plant which yields well and is preferred by commercial producers. Increasing labor costs for such specialized techniques has reduced the supply of grafted plants and it is now more difficult to find sources which can supply quantities required for field plantings. Another difficulty in production of grafted plants is maintaining propagating stock free of bacterial crown gall organism (Agrobacterium gypsophilae) (3, 4, 13, 16, 20, 21). Once in a stock, crown gall is very difficult to eradicate. In production of grafted plants from root cuttings clean rootstocks are essential; thus raising considerably the cost of production.

Own-root plants. Vegetative stem tip cuttings of ‘Bristol Fairy’ can be readily rooted (6) and this technique is used for the majority of commercial production. Vegetative cuttings should be taken from stock plants before flower initiation begins. Gypsophila cuttings resemble carnation cuttings (both plants are in the Caryophyllaceae family (1), and are handled in a similar manner. Stock plant shoots that begin to elongate and become thin (thus indicating flower initiation) should not be used as cuttings for propagation. Lower leaves on cuttings are removed and the stem base is dipped in a rooting hormone. Propa-
First plantings are made during September or early October. The main limiting factor for early production and flower quality is that northern growers experience high temperatures in late summer or early fall. This is a poorly drained soil during hot weather. Where possible, growers plant gladiolus production in open field culture on un-fumigated soils. Where possible, growers plant gladiolus production in open field culture on un-fumigated soils. Where possible, growers plant gladiolus production in open field culture on un-fumigated soils. Where possible, growers plant gladiolus production in open field culture on un-fumigated soils.

Plants root satisfactorily in about 3 weeks. Plants may be sold to growers either as rooted cuttings in 2½” pots or as one year old plants with mature large fleshy roots. When year old plants are sold, the top vegetative growth is removed by the grower and roots are trimmed for packaging. Roots of 'Bristol Fairy' are considered by some growers to be weaker and more disease susceptible than the G. paniculata rootstock used on grafted plants. Own-root plants are thought to yield somewhat less than grafted plants but no data are available to substantiate this. By the same standard, one-year plants supposedly produce more flowers than rooted cuttings even though cuttings grow rapidly and make a good sized plant the first year. Plants from cuttings require longer to flower than plants from year-old roots.

**Culture**

*Planting.* Plants are usually purchased from northern growers in late summer or early fall and first plantings are made during September or October. A critical part of gypsophila culture at this time of year is keeping the plant roots from waterlogging in hot weather. A heavy rain and/or a poorly drained soil during hot weather can cause the loss of an entire field of plants in an afternoon as roots rot quickly under these conditions. For this reason many growers wait for planting until heavy summer rains are past and high temperatures moderate in the fall. This is the main limiting factor for early production and is one reason little gypsophila appears on the market before November and December. Good drainage is absolutely essential for this crop. Much of the gypsophila in Florida is grown similar to gladiolus production in open field culture on un-fumigated soils. Where possible, growers plant in new land each year to escape the buildup of disease organisms which occur if gypsophila is grown repeatedly in the same location. Soil fumigation with tarped methyl bromide or Vorlex is desirable and will allow repeated production in a given soil. If the land is subject to flooding, the plants should be set on rather high beds to improve drainage. Plants are usually set about 2' - 3' apart and drainage ditches every 5-10 rows. This provides a plant population of about 3,500 to 5,000 plants per acre.

Harvest of flowers from September-October plantings of cuttings will usually begin in December and continue through March. There is normally much variability in time of flowering of individual plants. If older plants (roots) are planted in the early fall, some flowers can be expected in November with major harvests in December through January. In greenhouse experiments, lighting of plants each night has resulted in earlier flowering of plants (15) but the extra yields probably would not warrant the additional costs of lighting. Several plantings should be made at 5-7 week intervals until December in order to extend the flower season until June. Gypsophila plants are fairly tolerant of frosts and can be field grown successfully in any chrysanthemum producing area. Plants are as tolerant of frost as calendula or stock, but less tolerant than snapdragon or pansy (9).

*Insect control.* Gypsophila grown in open fields is host to several destructive insects for which some control must be applied. Only the more common and destructive species are discussed here.

*Moths.* Adult moths seek seclusion among plant foliage and weeds during daylight but become active at night and often fly long distances to locate an appropriate host plant. Eggs are laid usually on the host leaves or stem either singly or in masses of a few to several hundred. These eggs hatch within a few days and larvae begin to feed and cause severe damage. Moths that attack gypsophila include loopers, armyworms and cutworms.

*Loopers.* The cabbage looper, Trichoplusia ni (Hübner) and soybean looper Pseudoplusia includens Walk are the most persistent loopers found on gypsophila. Larvae are slender bodied, pale green with stripes and move in a looping or inch-worm manner. They hatch from eggs laid singly and their feeding results in partially consumed ragged leaves with large holes. Loopers may be controlled with any of the better formulations of Bacillus thuringensis (14).

*Armyworms and cutworms.* Common pests included in this group are beet armyworm, Spodoptera exigua (Hubner), southern armyworm, S. eridania (Cramer), and granulate cutworm, Feltia subterranea (Fab.). Damage by the armyworms is similar to looper injury but more extensive. Larvae are gregarious and may consume an entire plant or branch. Beet armyworms are pale to dark green, southern armyworms brown with black velvet appearing patterns. Early stages of the former species behave as a webworm, spins a web tying the leaves together and feeds from within the enclosure. Cutworms spend the day near the soil line but leave this shelter to forage at night.
They are large pale brown larvae that curl into a C-shaped form when molested. Armyworms and cutworms can be controlled with methomyl or carbaryl (14).

Leafminer. These insects are larvae or maggots of small flies with black and gold markings. The most common are species of *Liriomyza*. The adults lay eggs in the leaf tissue by inserting a blade-like ovipositor. This puncture causes sap to flow from the wound and this sap forms a source of food for the adults. Single eggs hatch within a few days and the tiny maggot begins to tunnel within the leaf leaving a white serpentine trail. Leaves may be heavily damaged by feeding tunnels and activity of these pests may lead to secondary infections from disease organisms. Mature maggots emerge from the tunnel, drop to the soil and become inactive puparia from which the adult fly emerges within a few weeks. Azinphosmethyl, diazinon or zectran provide the best control measure (14).

Red Spider, Spidermites. These tiny pests, about 1/50th" long, greenish, reddish or yellowish, are not insects or spiders but mites. They cause damage by feeding with needle-like mouth parts which puncture individual plant cells and extract fluids. All stages—egg, larva, nymphs and adult are present at the same time on the host. Under optimum conditions a generation can be completed in 10-14 days. Each female lays singly many eggs over a 20-30 day period, hence, generations overlap. Between each stage of development is a period of inactivity during which molting occurs. During this period, treatment for control is less effective since the new skin is protected by the molted skin. Consequently, treatments applied at three or four day intervals result in better control of this pest. Sprays and systemic materials can be used (14).

Thrips. Thrips most likely to be troublesome are the flower thrips, *Frankliniella* spp. Populations build up on many alternate host flowers (weeds, clover, citrus) during spring and migrate to fields of gypsophila where they infest the tiny blooms. Their rasping and shredding of tissues result in yellowing or browning of the flowers and wilting or secondary disease development. Protection should be given to the plants during heavy thrips flights by sprays of endosulfan or azinphosmethyl. If aldicarb has been used for spidermite control, additional treatments may be omitted.

Aphids. Occasional pests of gypsophila include aphids, primarily the green peach aphid, *Myzus persicae* (Sulzer). Large populations seldom develop, however, and treatment may not be required. The major cause for alarm from this pest is the presence of honeydew secreted by the aphids onto the foliage which provides a medium for pathogen development. Plants appear to be covered with a black soot-like mold which may affect photosynthesis through light reduction and hence affect yield. If treatment is required, aphids can be controlled with dimethoate, zectran or oxydemeton methyl (14).

Saprophytic mites. Included here are the several species of saprophytic mites found generally on rotting, diseased bulbs, corms, tubers or rhizomes. The growth of gypsophila from an underground foodstorage organ often provides an ideal condition for mite infestation. Large populations may become prevalent when the soil is wet and the roots decay. These organisms feed on the rotten plants and pathogens but may mechanically spread unwanted disease-causing pathogens throughout the soil. The best treatment for mite control is in complete disease control and prevention of decaying plants through improved drainage.

Nutrition and Weed Control. In addition to water damage, gypsophila roots are reportedly sensitive to herbicides (7) and high soluble salt levels. Little research information is available in either area but several growers have mentioned herbicide injury. Weed control can be difficult as plants are in the field many months and sprawl over an area 3' - 4' in diameter, making mechanical cultivation around plants difficult.

Moderate fertilizer schedules should be followed—somewhat similar to those used for gladiolus, and considerably less than for chrysanthemum culture. Superphosphate and fritted trace elements should be incorporated during soil preparation. Nitrogen and potassium sources should be applied at planting and periodically (each 3-5 weeks) during crop growth. Total amount and number of applications will depend on soil types, rainfall during the season, etc. Soluble salt readings of the normal sandy soils of Florida flower areas should be maintained roughly in the range of 800-1200 ppm (1:2 soil:water by volume. See Waters et al (22) for details) with a pH of 6.5-7.5. Gypsophila will tolerate higher pH ranges than most flower crops as it is reported to grow best on dry, calcareous gravelly soils (2, 5, 20). The name "gypsophila" literally means "gypsum-loving," referring to the native habitats of the plant genus (1). Consequently gypsophila should grow very well on the "rockland" soils of Dade county, although no producers of gypsophila are...
Flower Harvest and Post-Harvest Handling

This is one of the most critical and difficult aspects of successful gypsophila culture. Gypsophila plants produce flowers in a large, panicle-like compound diachasium in which individual flowers do not open simultaneously. The inflorescence is characterized by development of a single branch at each node giving an appearance of alternate branching. The tip or apex of the panicle opens first and must be harvested separately before the entire panicle is open. The flowers are sensitive to water deficit and intense sunlight, and will brown and shrivel easily if subjected to stress conditions. When flowers are overmature they are not saleable; therefore, harvesting requires a well-trained employee with an experienced eye to cut stems with flowers open—but not overmature. Plantings should be harvested frequently to obtain the highest quality flowers. Hot, dry winds can quickly produce stress conditions which desiccate flowers and can destroy whole fields. Flowering stems are usually cut 10-14” long, graded into a 6-10 oz. bunch and the stem ends wrapped with a rubber band. A bunch may vary from 5-25 stems depending on quality and stage of the harvest at any given time. Flowers are very susceptible to drying after harvesting and must be kept in water under refrigeration to maintain quality. It is also advantageous to hold flowers in water during the shipping period, however, shipping containers holding water is difficult and major airlines will not accept flower packages which contain water. Gypsophila stems begin to decompose quickly after being placed in water and can be very disagreeable to handle and are unpleasant smelling. Flowers held in water at 40°F will sustain shipping quality better than flowers held at 33°F (11). Boxes lined with polyethylene film will reduce moisture loss but botrytis may be a problem if flowers are not cooled before packing and moisture condenses on the flowers. The ornamental crop market report summary (18) gives the following information:

“A 18” x 20” x 24” wire bound crate is used for truck shipment. Some 20-30 bunches with stem ends immersed in a bucket of water are packed in a crate. When sent by air, 60 bunches are packed in a 11” x 18” x 48” carton without water. Grading is done according to stem length and marketed as small, medium and large. It is estimated that 60% is consigned to city markets while about 40% is sold on an FOB shipping point basis. The FOB price to wholesalers ranges from $.70 - 1.00 a bunch for all three grades with most sales at $.90 - 1.00.”

Of course, individual growers vary considerably in grading and shipping techniques used.

Cooperative research by USDA and AREC-Bradenton has shown gypsophila responds well to flower preservative solutions (11). Flowers will keep and continue to grow and develop in a solution of 200 ppm of 8-hydroxyquinoline citrate (8-HQC) and 2% sucrose (S). In water little further development of flower opening occurs after harvest and flowers may shrivel when in storage or in arrangements. In 8-HQC + S gypsophila flowers continue to open until every bud in the panicle is fully expanded, and will last up to 3-4 times as long as flowers held in water. Tests have indicated that gypsophila can be harvested and bunched when panicles are in tight bud (when first flowers on a panicle begin to open). Bunches are then placed with stems in 8-HQC + S and the containers are placed in a holding area at 72-76°F for opening to the commercial stage. Flowers handled this way open much better than normal development in the field and the dangers of flower browning, shriveling and disease losses which often occur in the field are greatly reduced if not eliminated.

In another experiment, it appears that the rapid decomposition (and unpleasant odor) of cut stems in water due to water molds may be reduced or eliminated by adding sodium benzoate to the holding solution without any deleterious effects on lasting life or quality of the flowers. The use of 8-HQC + S and sodium benzoate are both preliminary observations but results indicate growers, retailers and consumers could greatly benefit by evaluating these observations.

Dried Flowers. A good market exists for dried gypsophila flowers for use in both fresh and dried flower arrangements by florists. In northern wholesale flower markets dried gypsophila often brings twice the price of fresh material; selling for $2.50 to $4.50 per bunch on the New York and Chicago markets. Dried gypsophila is presently produced in other areas of the U.S. An opportunity exists for Florida growers and could be exploited by enterprising persons. Although usually dried in the bunch form, individual panicles can also be pressed and dried (19) for use in floral plaques, for sealing in transparent or translucent plastic, for screens, and for Victorian bouquets. Bunches can be dried by hanging them upside down in a
relatively dry dark room. Rapid drying with a hot air blast will cause excessive shriveling and brittleness. Packaging and shipping are the major difficulties in merchandising this produce because dried flowers are brittle and break easily when handled.

**Digging and Storage**

Although gypsophila plants are perennial in temperate areas, roots must be dug and stored during the summer months in Florida as plants in the field are quite susceptible to disease losses during extreme heat and moisture conditions in Florida during June, July and August. Plant losses in storage have often been as high as 70%. Tops of the plants should be cut back before digging, leaving 2-4” of the stem above ground. When plants are dug, the large fleshy roots usually need trimming for convenient storage. Normally, roots about 10” long are stored but various growers retain different amounts of the roots—varying from 6” to 18”. On young plants which have not developed the large fleshy 1-2” diameter roots, the entire root system can be stored.

Trimming roots for storage is one time and place for rapid spread of crown gall bacteria (16). Every effort should be made to maintain sanitation to reduce losses at this point. Growers should discard badly infected plants as they store poorly and have low productivity the following season. It is probably impractical to discard all plants showing any sign of crown gall as it is almost universally present. If small lesions up to one inch in diameter are present, the roots can be saved for one more season of production. Lesions larger than this generally weaken the plant too much for economic production. Cutting tools should be disinfected between plants to reduce the disease spread. A 2-minute dip in calcium hypochlorite solution has been reported effective in reducing spread of crown gall in grafting or trimming of gypsophila plants (13).

The two major causes of root storage loss are desiccation of the roots or excess moisture in the packing media. If roots are piled loose in containers, or even packed in various media open to the air, desiccation will occur under conditions existing in most storage rooms and roots will die when a critical moisture level in the tissues is reached. Sometimes when containers are stacked only those in the outer layer will be affected. Satisfactory storage can be achieved without a packing medium if roots are held in crates in storage rooms maintained at a high humidity. Packing in wet media to reduct drying losses will result in severe disease losses in storage and if temperatures are above 40°F, excess sprouting will also occur. Our research has indicated that lining storage containers with a moisture barrier of polyethylene film and packing roots in dry peat or wood shavings will reduce storage loss.

The polyethylene film should be overlapped or folded at top but not sealed tightly. It is important to use a material such as polyethylene which allows gas exchange yet forms a moisture barrier. Anaerobic conditions in the root areas will cause severe root damage. Storage at 32-35°F is most desirable but if packed in a dry media, roots can be held at 42-45°F without excess sprouting development. Sprouting occurs readily at 45°F if adequate moisture is present. Packed properly and held at 32-35°F, roots can easily be stored 8-12 months.

When planting in hot weather, boxes containing roots should be removed from cold storage several days before planting and allowed to come to outside air temperature. New stock (cuttings or young roots) planted in the fall can normally be dug and stored the following two summers for a total of 3 years of production. Uncontrolled crown gall disease in stock can limit production to one or two seasons. Stock can rarely be maintained in a healthy and vigorous state for four or more years; therefore, a grower should plan on replacing 25-40% of his stock each year. Some growers feel that with disease losses and costs of digging and storage of roots, it may be most economical to purchase new stock each year.

**Literature Cited**

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