Section 21

Lisianthus (*Eustoma*)

Mark S. Roh, USDA

Eustoma grandiflorum (Raf.) Shinn., commonly known as lisianthus, belongs to the Gentianaceae and in nature is found mainly in the wet prairies of Nebraska, Colorado, and Texas. *Eustoma* forms tap roots and grows very slowly during the winter. The shoots elongate in the spring and grow up to 3 feet in height.

Although *Eustoma* is native to the United States, all commercially important hybrids have been bred in Japan since its introduction to Japan some 60 years ago. Initially only purple-flowered *Eustoma* were available; but now, more than 150 different commercial varieties are available, with purple, pink, or white flowers.

Eustoma was introduced to U.S. growers and consumers in the early 1980s. The plant requires about six months from seed sowing to flower. Despite this long cropping time, *Eustoma* has become popular because of its long keeping quality under low light, either as a cut flower or pot plant. Although most of the *Eustoma* cultivars that were introduced from Japan in early 1980 were used for cut flower production, genetic dwarf cultivars were introduced into the trade by mid-1980 and *Eustoma* was grown as a potted plant without using growth retardants.

In the United States, *Eustoma* is largely grown as a cut flower in California and as a potted plant for local markets, since pot plants are not easily shipped over a long distance by truck. Semi-double flower cultivars and bicolor cultivars have become popular recently. Currently, no true red flower cultivars are available. *Eustoma* are mainly produced late in the spring, from May to July, but can be produced from February to late October.

Overall Growth And Development

The growth and development period can be divided into two stages, according to the temperature requirement and growth rate. The first stage is a seedling growth period that lasts about three months, when seedlings grow very slowly and form about four to five pairs of leaves. During the seedling growth period, temperatures should be maintained around 45 to 60°F at night to ensure proper stem elongation and to increase the number of flowers. Temperatures must be maintained lower than 70 to 75°F to prevent rosetted growth for most of the commercial cultivars. Short photoperiods, less than 12 to 13 hours, should be provided during the seedling growth stage. Providing optimum temperature and light during this seedling stage is very important to produce quality plants.

The second stage involves stem elongation, flower bud initiation, and flowering that lasts about three months. During this stage, higher temperatures (ranging from 65 to 70°F at night) and a photoperiod longer than 13 hours a day are required for flowering.

Growers can produce crops by sowing seeds or growing from seedlings. It takes about six months from sowing to flowering. However, seedling plugs can be purchased to save growers the efforts of growing seedlings, allowing them to force *Eustoma* flowering in four months.

Cultivars

New hybrids with different flower bud shape, color range, either solid or bicolor, and single- or multi-petalled flowers are introduced almost every year from many major seed companies (Figures 21-1 and 21-2). From Japan, where most of the breeding has been done, more than 150 cultivars for cut flower use are available. Almost all cultivars bred in Japan showed high temperature-induced rosetted growth. 'Little Belle Blue,' the first genetic dwarf suitable for pot plant production (Figure 21-3), was developed at the U.S. Department of Agriculture, ARS, U.S. National Arboretum, Floral and Nursery Plants Research Unit. Only a few dwarf cultivars exist for potted plant use, including 'Blue Lisa,' 'Mermaid White,' 'Pink,' and 'Blue.'

Overall Growth And Development

Propagation. *Eustoma* is propagated by seeds, although tissue culture and stem tip cutting methods can be utilized. Seeds are very tiny (600,000 seeds/ounce), and pelleted seeds (20,000 seeds/ounce) are now available. Since seeds are very tiny, they must not be covered after sowing. A minimum of 100 footcandles of light for six hours a day is required for germination. Optimum germination temperatures are about 70 to 75°F. Germination will be completed in 21 days; seeds should not be allowed to dry during this period. Placing seed pans

or plug trays under a mist bench will keep the media and seeds moist.

When seeds germinate, trays or pans are transferred from the mist bench to the greenhouse maintained at 70°F day/60 to 65°F night. Growing seedlings under supplemental high intensity discharge lighting for 9 to 12 hours during the fall and winter growing seasons will speed up seedling growth. Seedlings can be transplanted if necessary about one month after germination.

Figure 21-1. 'Mariachi Pink'

Figure 21-2. 'Echo Blue Picotee'

Seedling growth and transplanting. Maintain temperatures at 60 to 65°F day/45 to 60°F night during the seedling growth stage for about two months after germination. Temperatures should not be higher than 75°F during the day or night to avoid rosetted growth. Once seedlings show rosetted growth, it is very difficult to correct the problems later when stems start to elongate (Figure 21-4). This high temperature-caused rosetted growth is sometimes confused with the natural slow growth of seedlings at low temperatures, which do not present any problems at the time of stem elongation.

If not initially grown in plug trays, seedlings can be transplanted into plug trays about one month after germination when two pairs of true leaves are formed. The root system of tiny seedlings is very vigorous and chances of survival after transplanting are very high. Seeds can be directly sown into 1- to 2-inch plugs to skip the initial transplanting. Root injury after the initial transplanting is not a serious problem compared to root injury after final transplanting.

When about five pairs of true leaves are formed and the youngest leaves start to grow upward (showing the beginning of stem elongation), seedlings are finally transplanted into beds at 10 x 15 cm spacing if they are to be grown as a cut flower crop. Roots are very tiny and easily damaged; care is needed to avoid injury. If seedlings in plug trays are transplanted, root injury is minimized. When the final planting is done after internode elongation, the incidence of wilting will be increased.

Figure 21-3. 'Little Belle Blue,' the first dwarf cultivar for potted plant production, was developed at the USDA, Beltsville, Maryland.

Figure 21-4. Seedlings showing normal growth (5th and 6th rows) and early signs of rosetted growth (3rd and 4th rows).

Seedlings should be fertilized every other week at 100 ppm N using a well-balanced water soluble fertilizer or calcium nitrate plus potassium nitrate. Since seedlings are growing very slowly over a three-month period, fertilization should not be overdone.

Stem elongation and pinching. Once seedlings are transplanted, their stems start to elongate. Depending on temperature, they will take about three months to flower. Although *Eustoma* forms bottom breaks after pinching, pinching is not recommended for pot plant production, because flowering is delayed and each break has fewer flowers.

Pinching may be necessary if bicolored or multipetalled cut-flower cultivars are to be grown as potted plants. It is essential to determine the proper location of the pinch. Because not all breaks grow uniformly when plants are pinched at the lowest node, pinch at the second node to obtain two uniform, strong breaks. Compact and bushy plants can be produced by pinching and treatment with growth retardants.

Flowering. For flowering, high temperatures and a long-day photoperiod are required. *Eustoma* generally takes about 90 to 120 days to flower after seedlings are transplanted. Although *Eustoma* flowers earlier under a long-day photoperiod, it is not sensitive to photoperiod. Plants require more than 60 days of long-day treatment to accelerate flowering by about 20 days.

When the terminal flower of each break is open, small flower buds can be removed, although it requires intensive labor, so more than 15 flowers open simultaneously. With pink and particularly purple flower cultivars, tiny flower buds do not develop to full color under a home environment, when temperature usually is high and light intensity is low.

Growing Medium, Nutrition, And Watering

Eustoma plants can be grown in any light, porous and well-drained medium high in organic matter that has a soil pH near 6.5. When pH is lower or higher than the optimum level, the number of flowers is reduced. In addition, when soil pH is low (acidic), young leaves become chlorotic and growth is inhibited.

During the slow-growing seedling period, fertilize seedlings with 100 ppm N every other week with a well-balanced water soluble fertilizer that contains a high percentage (50 percent to 60 percent) of nitrate nitrogen.

Once plants start to grow rapidly after transplanting, they can be fertilized with 200 ppm N every week. A slow-release fertilizer that lasts three to four months can be incorporated into the medium at the time of transplanting. When young leaves of 'Kiri no Mine' plants were sampled when the stem was about 6 inches tall, the leaf analysis showed:

N = 4.0%	P = 0.62%	K = 3.2%
Ca = 0.37%	Mg = 0.56%	Mn = 81 ppm
Fe = 121 ppm	Cu = 7.3 ppm	B = 36 ppm
Zn = 80 ppm	Mo = 1.49 ppm	

Information on how water quality affects the growth of *Eustoma* is not currently available. During the seedling growth period, do not overwater; but when stems start to elongate rapidly, the media should not be allowed to dry out.

Temperature And Photoperiod

Temperature is the most important environmental factor for high quality plants. *Eustoma* should be grown at cool temperatures during the early seedling growth period to obtain strong seedlings, but flower bud initiation is promoted by high temperatures and a long-day photoperiod.

Seedling growth stage. For seed germination (Stage 1: 14 to 20 days), maintain temperature at 70 to 75°F with misting. Stages 2 through 4 – During the three-month-long, slow-growing period, optimum temperatures are 60 to 65°F during the day. Optimum night temperatures are 60°F (Stage 2: 20 to 30 days), 45 to 55°F (Stage 3: 20 to 30 days), and 50 to 60°F (Stage 4: 20 days). Raising temperatures higher than 65 to 70°F at night during Stages 3 and 4 does not shortened the seedling period, but causes high temperature-induced rosetted growth in most cultivars grown for pot plant use. Long-day treatment for 30 to 45 days does not shorten the seedling growth period or affect time to flower significantly. However, an extended long-day photoperiod during this period can accelerate flowering, increase stem length, and greatly reduce the number of flower buds.

Stem elongation, flower initiation, and flowering. Stem elongation, flower bud initiation, and flowering are influenced by both temperature and photoperiod. Floral initiation for early flowering cultivars occurs when plant height is about 4 inches with five to seven pairs of expanded leaves. The critical photoperiod required for floral initiation is about 13 hours. About 30 days are required for both development stages – from the time of floral initiation to the visible buds and from the visible buds to flowering of the terminal flower buds, when the

greenhouse temperature is maintained around 70°F during the day and 60°F at night.

Long-day treatment can be given either as a day extension or a night interruption. Day extension lighting occurs from 6 p.m. or midnight for six to eight hours, or immediately after sunset or before sunrise, respectively. As a day extension, a minimum light intensity of 15 to 30 footcandles at plant level is required. This light intensity can be obtained by spacing 100 watt incandescent bulbs 4 feet apart and 4 feet above the plant. Day-extension treatments result in taller plants.

Long-day treatments as a night interruption can also be obtained by lighting in the middle of the night for four to five hours from 10 p.m. to 2 or 3 a.m. In this case, plant height is not increased. Therefore, night interruption is recommended for pot plant production. Light intensity of 45 footcandles will ensure a uniform response.

Eustoma respond to photoperiod, but lighting for 30 days is not enough to affect flowering significantly. Therefore, lighting longer than 60 to 90 days is recommended, starting immediately after the first sign of stem elongation. However, lighting should start after the final transplanting. The effect of light quality on stem elongation has not been investigated.

Marketing

When plants are grown well, more than 40 to 60 flower buds are formed from four to six upper shoots. The terminal flower opens about 10 days earlier than the largest flower bud of each shoot. The terminal flower bud is typically removed so that four to six of the largest flower buds open simultaneously at harvest. Small flower buds will not develop, and the flower stem will start to bend after harvest. Therefore, small flowers can be removed to increase the quality of cut flower stems. During late-spring flowering, greenhouse temperatures higher than 75 to 80°F should be avoided.

Temperatures should be maintained at 60°F about two weeks before flowering to promote stem strength and flower color. Individual flowers last up to 14 days after opening. Lighting with fluorescent tubes could increase the flower color of the small buds that did not open at harvest. At harvest, leaves will wilt rapidly if cut stems are left in the greenhouse. Place the cut stems immediately in water with floral preservative and keep them at about 50°F before marketing. Vase life is increased when harvested stems are kept continuously in 4% sucrose + 200 ppm 8-hydroxyquinoline citrate (8-HQC) or kept by pulsing for 24 hours with a solution containing 10% sugar, 300 ppm citric acid, and 250 ppm 8-HQC.

Physiological Disorders

Temperature-related symptoms. For early flowering in the spring, seeds must be sown in the fall when temperatures are high. High temperature-induced rosetted growth is a major problem (Figure 21-5). Once seedlings show signs of rosetted growth, it is very difficult to correct this problem. Although this could be prevented by subjecting seedlings to low temperatures (45 to 50°F for more than 10 hours at night for about 30 to 45 days) (Figure 21-6) or treating with gibberellic acid, stems fail to elongate normally and the number of flower buds is decreased. High temperature-tolerant cultivars are not available commercially. In addition to high temperatures during the seedling growth period, a natural short day during the stem elongation period will require the use of lights to provide long

Figure 21-5. At flowering, various degrees of high temperature-induced rosetted growth are evident. Plant on the far right is not affected by high temperature.

Figure 21-6. Depending on the cooling of the seedlings, some plants will flower normally and others will exhibit high temperature-induced rosetted growth.

days or interrupted nights. Once again, *Eustoma* is not too sensitive to long-day photoperiods. Therefore, forcing *Eustoma* for the winter season will require great attention to produce quality plants.

Nutrition-related symptoms. Under normal greenhouse growing conditions, no major problems have been observed. However, calcium deficiency symptoms can occur at visible bud stages (Figure 21-7), particularly when the light intensity is very high. The tips of the young leaves may fail to expand, and the terminal flower bud may become encircled (trapped) inside the curled leaves.

Growth Retardants

When cut flower cultivars are grown as a pot plant, stem height should be reduced by growth retardants and by pinching. Ancymidol, paclobutrazol, and dminozide have been used successfully on cut flower cultivars when grown as a potted plant. However, new dwarf cultivars suitable for pot plant use do not require growth retardant applications and pinching.

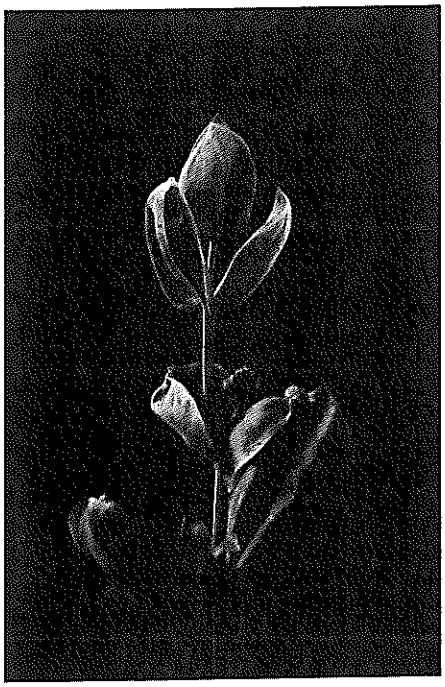

Figure 21-7. Calcium deficiency symptoms.

Pests, Insects, And Diseases

Botrytis and damping-off fungal diseases can be a problem when humidity is high during seedling growth stages, particularly when seeds are oversown. At visible bud stage, root rot or crown rot becomes a problem. Plants sometimes do not wilt or die suddenly, but undergo wilting and recovery from a wilting cycle for more than 7 to 10 days before eventually wilting completely. Proper fungicide treatment may correct the problem. However, keeping growing media moist with careful watering and reducing light intensity could solve the problem.

Whiteflies during growth and thrips at flowering should be controlled using registered chemicals. Several viruses, such as Bean yellow mosaic and tobacco mosaic viruses, have been reported, although they are not a major threat for quality cut flower production.

Crop Scheduling

Table 21-1 lists suggested schedules for cut flower and pot plant production of *Eustoma*, assuming that it will take six to seven months to produce cut flowers and six months to produce pot plants. The production scheduling will also vary whether you are growing *Eustoma* in the greenhouse, under a protected house, or in the open field. Select early flowering cultivars and consult with your seed companies for recommendations and the newest cultivars.

Table 21-1. Timetable to produce *Eustoma*.

A. Early forcing – with long-day treatment	
1. Sowing seeds	September - October
2. Final transplanting of seedlings	November - December
3. Long-day treatment	January - March
4. Harvest/marketing	April
B. Normal forcing under natural photoperiod	
1. Sowing seeds	November - January
2. Final transplanting of seedlings	January - March
3. Harvest/marketing	June - July

OFA