

History

Kalanchoes are increasing in popularity in the United States because of their improved quality, flower color range [pink, rose, red, purple-red, purple, orange, orange-red, salmon, yellow, bicolored (e.g. Fides' 'Klabat' (Figure 20-1a) and its Bells series), and, now, even white! (Figure 20-1b)], attractive foliage (including plant shape), and the increased in-home longevity of the current hybrids. Also, there has been an increased demand for smaller sized pots at mass market outlets (Danielson, 1991). Plants in pots as small as 1.5 inches are popular for garden center sales. In Europe, kalanchoes are one of the most popular flowering plants (ranked 4th) for the home. More than 50 million are produced annually in the Netherlands alone, where it is ranked number one. Small foliage types with prominent, tube florets (e.g. 'Wendy') are popular in Europe as hanging baskets, a use for which Fides' Bells series is also becoming more popular in the United States (Anonymous, 1997; Versteeven, 1996). Kalanchoes are easily programmed to flower for any date simply by regulating the night length under which they are grown. Because of their long-night response (they're "short-day plants"), they naturally flower in U.S. greenhouses around the end of January. Once marketed, kalanchoes can remain flowering with minimum care in the home for six to eight weeks (Hessayon, 1994; Love, 1976; Pertuit, 1992b; Schwabe, 1985; Versteeven, 1996).

Kalanchoe (the genus) is derived from the native name for a Chinese species, while *blossfeldiana* (the species) is for the German hybridizer Robert Blossfeld, who introduced this plant to Germany from its native Madagascar. (Bailey, 1928; Bailey and Bailey, 1976; Johnson, 1986).

Today, Balfour Greenhouses, Ltd. of Ontario, Canada; Ball FloraPlant of West Chicago,

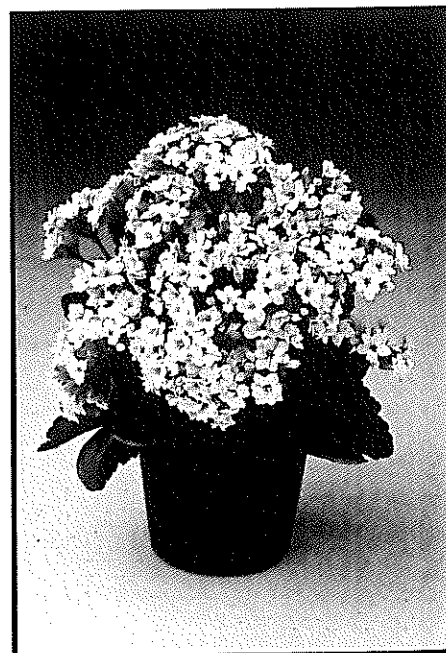
Illinois; J & L Plants of Amarillo, Texas; and, Mikkelsens, Inc. of Astabula, Ohio, are among the excellent sources of kalanchoes (all asexually propagated).

Botanical Information

Kalanchoe blossfeldiana Poelln. is a glabrous herb to subshrub (i.e. it develops woody tissue with age), upright in growth, with opposite leaves arranged in four ranks – like a cross, when viewed from above. The leaves of this crassulacean dicot are obtuse to acute, sinuate to crenate (upper half), 1 to 3 inches long, and taper to petioles about 1 inch long (Bailey, 1928, 1976; Hillman, 1962).

Its flower head is a cyme (i.e., a broad, determinate, branched, yet flat, inflorescence). The floret which terminates the primary axis matures first and acts like a physiological pinch, inducing paired branching of several nodes below it (Anonymous, 1995b, 1995d; Bailey & Bailey, 1976).

Lately, the Bells series is referred to "in the trade" as *Kalanchoe bryophyllum* cultivars (Anonymous, 1997). *Bryophyllum* (Salisb.) is one of the three section names of the genus *Kalanchoe* (Adans.); and not a species name in *Hortus Third* (Bailey &



Figures 20-1a and 20-1b. Kalanchoe flower color ranges from bicolors (e.g. 'Klabat' on the left to solid colors of pink, red, purple, orange, yellow, and even white ('Mt. Columbia' on the right).

Bailey, 1976). Plants in the *Bryophyllum* section have pendulous florets with an inflated, tubular calyx. Some often have plantlets on their leaf margins. 'Mirabella' (Figure 20-2) has *K. Manginii* (Hamet. & Perr.) (*Bryophyllum* section) in its pedigree, while the real hanging basket types like 'Honey Bells' (Figure 20-3) are *Bryophyllum* and *Kitchingia* (the third section) crosses (Anonymous, 1997; Bailey, 1976; Vlieland, 1996).

Propagation

Few kalanchoes are propagated from seed today. Asexual multiplication of cultivars via terminal or leaf petiole cuttings is far more rapid and ensures a more uniform product than sowing.

Growers can secure patented cultivars from specialists or, with a license, from their own stock plants.

A four-hour, 10-foot-candle, fluorescent, mid-night break will ensure that the stock plants remain vegetative (Schwabe, 1985) and keep their internodes short. Ideally, 67°F nights will induce vigorous growth that will yield a new crop of shoots monthly for terminal cuttings. Terminal cuttings with only a couple of pairs of expanded leaves (about two thirds their mature size [Vlieland (1996)]) will root in a couple of weeks; once rooted and transplanted, they will be growing vigorously in only two more weeks. So, an additional month should be allowed in a forcing schedule if nonrooted cuttings are used. Cuttings root easily without an auxin aid before sticking; therefore, if used at all, a weak auxin concentration is adequate. Various propagation media have been recommended (Love, 1976; Pertuit, 1992b); however, any highly organic, well-draining media will do. Fides (Holland) roots stock plants in "glass-wool," a product from basalt (whimstone) rock, then inserts the plug into a prepared (pre-cut plug holes) glass-wool mat in a 2-foot tray. Each tray is over a gutter (Figure 20-4), and there are four gutters on each 100-foot bench (Vlieland, 1996).

Intermittent mist for kalanchoe cuttings produces fast results. Light shading may be necessary during the seasons of greatest light intensities (i.e. late spring, summer, and early fall). For the first week

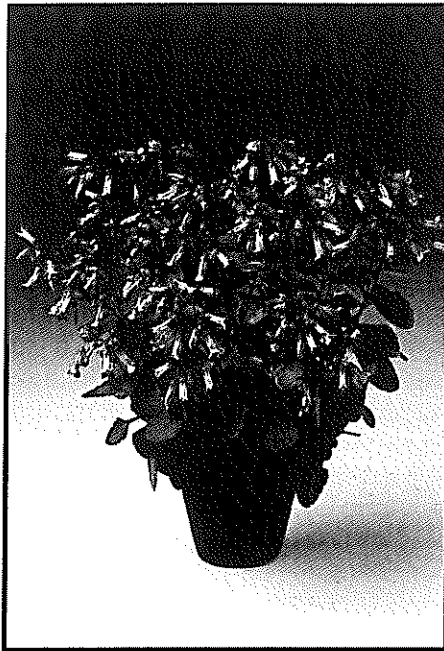


Figure 20-2. 'Mirabella' with pendulous or hanging flowers is typical of the *Bryophyllum* "type" kalanchoe.

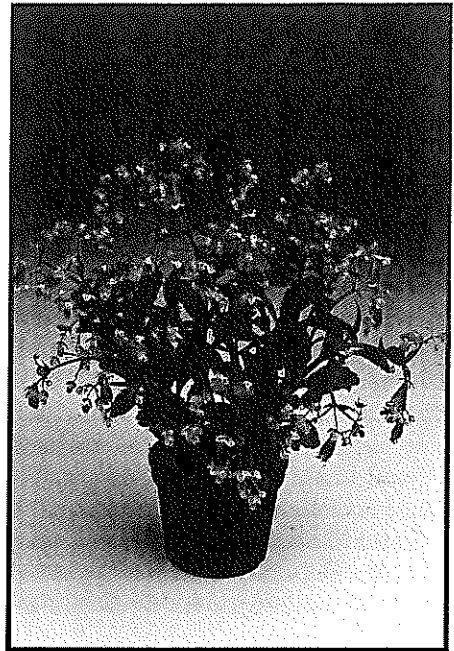


Figure 20-3. 'Honey Bells' is another "type" of kalanchoe that is suited for hanging baskets.

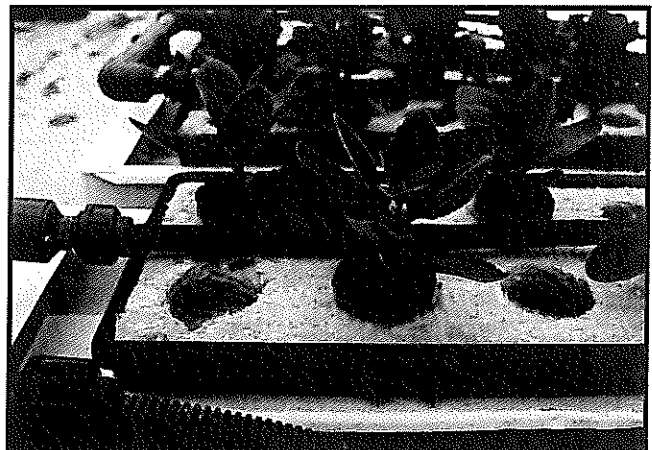


Figure 20-4. Kalanchoe cuttings root well in most well-drained media. One propagator ships rooted cuttings in "glass-wool" plugs.

(or until the cuttings have calloused), the mist cycle should be six seconds/three to five minutes during summer and about half of this (six seconds/6 to 10 minutes) in winter (Love, 1980).

It is recommended that the cuttings receive a light break as described for stock plants.

Nonrooted cuttings can be stuck directly into finishing pots and hose-misted, as necessary, until they are rooted. This produced a finished product in three weeks more time, but it's of about the same quality as using rooted cuttings in the finishing pot. This labor-saving procedure is popular. Ball pro-

duces these in its Costa Rica facility; however, its rooted cuttings are produced in Florida.

J & L Plants (Amarillo, Texas) has detailed schedules for kalanchoe production via direct sticking of nonrooted cuttings (Irwin, 1996a).

Growing Media

With kalanchoes, as with most plants, the growing media should be well drained and well aerated (Laurie, 1958). Several recommend half peat moss (Heins, 1997; Anonymous, 1995a; Danielson, 1991; Post, 1959), while Love (1980) used less peat than this, as did Pertuit (1973a) who used equal volumes of peat moss, pine bark (soil conditioning grade), and builder's sand. The growing media should be adjusted with dolomitic limestone to a 6.0- to 6.5-pH range (Love, 1980; Pertuit, 1973a, 1973b) to ensure an ideal zinc-to-phosphorus relationship (Nelson, 1981).

Potting

Most kalanchoes in the United States are still marketed in 4- to 6.5-inch pots, which work well with the loose, often soilless mixes in which kalanchoes are grown. Plastic pots are clean, and plants grown in them require less frequent watering than those grown in clay pots.

Kalanchoe cultivars vary in growth rate and foliage size. Love (1980) recommended that cultivars with small foliage be finished in small pots and those with large foliage be finished in larger pots. Mikkelsen (Anonymous, 1995b, 1995c) has schedules for 6-inch pots of kalanchoes with three cuttings per pot. Because they are not pinched, a finished product is produced in two weeks less time than is required for a single, pinched cutting in a 6-inch pot. The cost of the two additional cuttings could possibly be offset by increased profit resulting from the reduced production time and a higher priced product because of its improved quality.

Spacing

Many variables dictate kalanchoe spacing: the cultivar; whether plants are pinched; the number of cuttings per pot; the season; the production location; the projected finished size; and whether growth retardants will be applied. Danielson (1991) suggests four to six 4-inch pots per square foot; 5-inch pots at 7-inch spacing; 6-inch pots at 10-inch spacing; and 6.5-inch pots of three cuttings each at 12-inch spacing.

Pinching

Soft pinching (i.e. the removal of a couple of leaf pairs at the shoot apex) is often part of a production schedule, adding several weeks (depending on the season) to the schedule. With some schedules and some cultivars, pinching neither decreases plant height (Pertuit, 1973a) nor increases the number of flowering shoots (Lyons & Hale, 1987; Pertuit, 1973a). In others, it increases the number of flowering shoots but has no effect on plant height. And in still others, it can reduce plant height and have no effect on the number of flowering shoots (Pertuit, 1973a). Also, it does not always reduce cyme height (Pertuit, 1973a). Pinching, therefore, should really not be universally recommended, because it is not always necessary for adequate axillary growth and development of all cultivars (Pertuit, 1992b). Most of the newer cultivars are relatively free branching (Vlieland, 1996). A grower should know the cultivars he grows.

Pinched terminals can be rooted and used for future production, eliminating the maintenance of stock plants (Love, 1980).

Kalanchoes can be finished five to six days earlier (than with conventionally recommended pinching methods) if the so-called "late-pinch method" is implemented: pinch a week after the beginning of the long-night treatment. This method induces excellent branching and keeps the product compact, reducing growth retardant applications by half (Vlieland, 1996).

Light Intensity

Kalanchoes grow and develop well at light intensities of about 4,500 footcandles, which means shading is required from late spring through early fall. High light intensities play an important role in floral initiation in *Kalanchoe blossfeldiana*, but the specific mode of action is not clearly understood (Schwabe, 1954).

Kalanchoes exposed to lower light intensities just before the dark period will initiate fewer flowers than those exposed to higher intensities, a result that one might attribute to a light intensity/carbohydrate level effect. If, however, the length of the dark period is increased on the plants at the lower light intensity (i.e. reducing photosynthesis even more), they will produce about the same number of flowers as plants grown at the higher light intensity, which cannot be explained on the basis of a light intensity/carbohydrate level relationship alone. Higher levels of inhibitory auxins at low light intensities could be involved (Schwabe, 1954, 1972, 1985).

Water

Although kalanchoes are succulents and can withstand water stress relatively well, they should not be subjected to water stress during production. Both tube and subirrigation watering can work well. Hand watering should be done early in the day to ensure dry foliage before dark. Watering can be reduced slightly just before marketing.

Temperature

While kalanchoes grow well at 67°F nights and this temperature level is recommended (Anonymous, 1995a; Danielson, 1991; Grimm, 1994; Heins, 1997), high quality plants can also be produced at night temperatures approximately 5°F cooler than this, reducing heating (Love, 1987; Pertuit, 1992b). Identical day/night temperatures from 64 to 68°F also have been recommended (Vlieland, 1996). Warm nights seem appropriate for production in warm seasons. Pertuit (1977) found that kalanchoes at 60°F night temperatures initiated flowers sooner than those at 50°F or 70°F night temperatures, the latter temperature not causing "heat delay" (i.e. failure to initiate flowers under inductive nights because of high night temperatures). It is the high temperatures at the beginning of the dark period that cause heat delay (Hillman, 1962); therefore, blackcloth application in the afternoon should be delayed as long as possible.

Kalanchoes do not respond to negative "DIF" (or "inverted night temperatures") (Anonymous, 1995a; Grimm, 1994).

Humidity

A 75 percent to 85 percent relative humidity is ideal. If more than 90 percent, leaf drop, leaf yellowing, and floret damage can occur. If less than 70 percent, growth will be severely checked (Vlieland, 1996).

Fertilization

Alternatives to constant feeding with a completely soluble fertilizer such as 200-100-200: N-P-K (Anonymous, 1995a) include weekly applications (540 to 720 ppm: N, P, K) and the use of a slow-release fertilizer (e.g. Osmocote) as a supplemental source (Love, 1976). Fertilization subsequent to floret coloring is not necessary.

Zn, Fe, Mn, Cu, B, and Mo, important micronutrients required by kalanchoes, may be mixed into the growing media as fritted trace elements or applied as a soluble formulation (Love, 1980). Zn deficiency results in flattened stems that branch prolifically

(Nelson, 1981). A 75 ppm Zn chelate foliar spray should correct the problem (Heins, 1997).

Photoperiod

Floral induction and initiation. Kalanchoes are considered a classic example of the short-day plant (SDP). However, it is really the night (dark period), and not the day (light period) that controls flower initiation. Therefore, kalanchoes are SDPs because they initiate flowers when exposed to nights (dark periods) longer than their critical length.

Kalanchoe growth is not always "black or white," "vegetative or reproductive," as with most other plants. If not clearly induced to be vegetative nor clearly induced to be reproductive, kalanchoes produce growth intermediate between vegetative and reproductive – reproductive branching with a few florets intermingled with miniature leaves (Hillman, 1962).

On a 24-hour cycle, the critical nightlength for *Kalanchoe blossfeldiana* is about 12 hours; a couple of hours more than this should be employed in greenhouse production. Although only two long nights are required for floral initiation (minimum induction), the number of flowers initiated increases with additional long nights (Schwabe, 1985). For commercial production, a minimum of four to six weeks is recommended.

Floral development. Once flowers are initiated, they will reach anthesis regardless of the nightlength (Love, 1980); however, plants grown under long nights until marketing are of the highest quality (Grimm, 1994; Vlieland, 1996). Also, florets may not develop at the same rate under short nights as under long nights.

Kalanchoes are manipulated to flower for a projected date in much the same way as long-night plant mums. Kalanchoes are not, however, as sharply programmed as chrysanthemums; an additional one to two weeks of production are required in winter, when compared to summer production. Roughly, nine weeks is an average response time (e.g. 'Klabat'), although some cultivars (e.g. 'Mount Loa') need an average of only eight weeks while others (e.g. 'Tenorio') may require an average of 10.5 weeks. A three-week difference in production time between summer and winter can occur along the United States' northern border (Grimm, 1994; Heins, 1997). Older kalanchoe plants flower earlier than younger plants when both are grown under naturally occurring nightlengths.



Figure 20-5. As with other potted crops, height management has a direct impact on quality. Cultivar selection is an important aspect of height management.

Height Control

Kalanchoe cultivars vary in vigor, and some stretch too much in summer. Because height affects quality, it must be controlled. Height control may be accomplished by cultivar selection (Figure 20-5), physical control (e.g. pinching), environmental control (e.g. manipulation of the vegetative/reproductive cycle), and/or chemical plant growth regulator application(s) (Pertuit, 1992a).

Before growth retardants became major height control weapons, the unsightly elongation of the terminal cyme was avoided simply by controlling the nights – subjecting plants to only three weeks of long nights, then seven weeks of short nights (Seeley, 1952).

Chemical growth retardant applications enhanced kalanchoe quality by reducing plant height and peduncle/pedicele elongation. Those that have been successfully and reliably applied include B-Nine (daminozide), A-Rest (ancymidol), and Florel (ethephon). They have been applied as foliar sprays and/or “soil” drenches. It takes about three foliar sprays to produce retardation similar to that produced by one soil drench.

B-Nine (daminozide) works well as 2,500 to 5,000 ppm sprays applied two weeks after pinching. B-Nine sprays also are recommended when flower buds begin to show; the main effect when applied then would be a reduction in peduncle (flower stem)

length, not plant foliage height. The number of spray applications employed depends upon the B-Nine spray concentration applied, the cultivar grown, and the environmental conditions (i.e. more would be needed under conditions that promote axis elongation such as high temperatures and low light intensities).

A-Rest (ancymidol) has been used effectively as a foliar spray or as a soil drench (Carlson et al., 1977; Pertuit, 1973a). Two 50 ppm foliar sprays (applied a week apart, to run-off) will reduce total plant height (i.e. foliage height above soil and cyme length above foliage added together) when applied as early as eight weeks before or five weeks after long nights are begun. When foliar sprays are applied after long nights begin, the reduction in plant height is mainly a result of a reduction in cyme length rather than a reduction in foliage height (Pertuit, 1973a). As a soil drench, the best time to apply A-Rest is two weeks after long nights commence. A rate of 50 ml of 0.50 mg A-Rest per 4-inch pot applied then will reduce total plant height, mainly by reducing foliage height. When a soil drench of 0.75 mg (50 ml/4-inch pot) is applied then, A-Rest will reduce cyme length (Carlson et al., 1977).

Florel (ethephon) sprays of 250 ppm applied twice (a week apart) about a month after long nights begin will reduce total plant height by reducing cyme length, not plant foliage height. If increased to 500 ppm, foliage plant height and cyme length will be reduced. A Florel/water mixture is more effective at lower pHs because ethylene gas is freely released. Distilled water should be used to prepare this mixture if the pH of the water is near neutral (7) or greater.

Bonzi (paclobutrazol) has been applied to kalanchoes at 2 ppm (winter) and 4 ppm (summer), but the technique is very exacting (Vlieland, 1996). The Bonzi-application parameters involved need to be clearly defined; therefore, a recommendation for its use on kalanchoes would be risky.

Marketing Stage

Recommendations on inflorescence development for sales vary somewhat. Some recommend that florets should be fully opened at sales (Hesse, 1985; Love, 1980), because florets do not readily open under low light. Others (Anonymous, 1990b) say the key is that the central floret of most flowering branches must be open (i.e. once this stage is reached, the entire inflorescence will open). Usually about 50 percent of kalanchoe florets are open when the

plants are marketed. Even if they are marketed at the full flowering stage, kalanchoes will easily last six weeks in the home with minimum care.

Seasonal demand. As with many flowering plants, the most demand for kalanchoes is in late winter and spring; however, year-round demand is increasing. The smaller sizes (e.g. 4-inch) are sold in the mass markets and the larger size (greater than or equal to 6-inch) are sold by garden centers and florists.

Care during marketing. Ideally, kalanchoes should be shipped at 60°F, followed by bright light and around 60°F for display. They should be kept well watered. Chilling injury can occur if shipped at 35°F for eight days. Kalanchoes should not be crowded and should be displayed in a well-ventilated location devoid of ethylene, which can prevent floret opening and induce their premature fading and desiccation (Love, 1980). Apples and pears can produce particularly harmful amounts of ethylene (Mastalerz, 1977). Unfortunately, most supermarkets often offer kalanchoes for sale in their produce section.

Consumer care. Few plants are as long lasting in the home environment as kalanchoes. They always should be kept in a bright location, if possible. A reading lamp, for supplemental lighting, will help them retain their original color (Irwin, 1972).

Hanging basket production. Because the plants are grown as hanging plants, long internodes are desired. Therefore, growth regulators, which reduce internode length, are not part of their production program.

Compared to standard pot kalanchoes, those suitable for hanging baskets must be kept in much drier growing media, their cuttings take longer to root, and their pre-inductive vegetative phase is at least twice as long. Response times are more than nine and a half weeks.

Moderate nitrogen fertilization levels can induce foliar and floret burning if growth is checked. Light intensities greater than 4,000 footcandles burn the foliage, yet intensities just under this are best for vigorous growth (Vlieland, 1996).

Production Problems

Insects and mites. CAUTION: Kalanchoes are extremely sensitive to many insecticidal carriers (e.g. xylene), which can produce almost instant injury so severe that the plants cannot be marketed. To be safe, a wettable powder is suggested (Pertuit,

1992; Grimm, 1994). Dursban and Kelthane should not be used (Irwin, 1996c). Pesticide recommendations change frequently. A grower should precisely follow the current recommendations of the state Extension Service and the pesticide label.

• **Cyclamen Mites [*Steneotarsonemus pallidus* (Banks)]:** The sucking of the mites on immature growth produces distortion of new leaves and florets, which may not open (Pirone, 1978).

• **Citrus Mealybug [*Plancoccus citri* (Risso)]:** Mealybugs can be particularly difficult to control because they congregate in locations that are hard to spray (e.g. in the bases of petioles). Females are capable of producing hundreds of eggs (in a waxy sac) (Baker, 1978; Nakahara & Williams, 1980; Pirone, 1978).

• **Green Peach Aphid [*Myzus persicae* (Sulzer)]:** Another sucking insect, the aphid, is parthenogenic – females give birth to females, giving aphids the ability to produce a new generation each week and cover the plant in a couple of days. They are easily controlled (Baker, 1978).

• **Cabbage Looper [*Trichoplusia ni* (Hubner)]:** The cabbage looper larva usually appears from late spring to early fall. Each adult is capable of producing more than 200 eggs (Baker, 1978; Pirone, 1978).

• **Cutworm (various genera):** Night lighting attracts the adults into the greenhouse, usually from late spring to early fall. The caterpillar hides in the soil during the day and climbs onto the plant after dark, chewing its leaves and stem, sometimes cutting the plant off at the soil. The larvae can be effectively controlled with baits (Baker, 1978; Pirone, 1978).

Diseases

• **Powdery Mildew (*Sphaerotheca himuli* var. *fulgininea*):** Cultivars with thicker, darker leaves are most resistant to powdery mildew. The fungus grows best at cool temperatures and high humidities; hence, it may be controlled by proper heating and ventilating. Its mycelium may be spread to other plants by the wind and careless watering, infecting young leaves, causing them to curl, become stunted, then dry out and die (Pirone, 1978).

• **Crown Rot, Wilt (*Phytophthora cactorum*):** Black lesions appear at the soil line. The rot then extends up the stem through the plant, which wilts (Pirone, 1978). Proper growing medium selection and “sterilization” should help prevent it.

- **Viruses:** Various virus diseases have been identified in kalanchoes (Irwin, 1996d; Vlieland, 1996). Symptoms vary, but plants with chlorotic leaves, leaves that curl, leaves with spots or rings, streaked flowers, and/or distorted growth should be discarded.

Physiological Disorders

- **Oedema (Wart Disease):** Oedema first appears several days following overcast conditions of exceptionally high humidity, low light intensities, and a wet growing medium (Pirone, 1978). Stem and leaf cells are not able to release water quickly to the atmosphere; therefore, pressure builds within them until they burst, appear water-soaked, darker green, and subsequently, callous, producing an unsightly corky cell layer.

- **Heat delay:** As stated, high temperatures during the first part of the inductive dark period can prevent floral initiation. It is recommended that blackcloth be applied late in the day, when temperatures are cooler and the sun has begun to set.

- **Failure to flower (or few flowers):** Long nights of 14 hours applied for at least six weeks to kalanchoes at around 70°F maximum during the dark exposures will result in high quality plants that flower on schedule. Plants exposed to stray lights at night or inadequate dark periods may not flower.

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