Flower Forcing for Cut Flower Production with Special Reference to Thailand

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Abstract

Flower forcing is any operation to induce flowering at a desired period with the goals of producing flowers during off-season and specified date, and for sale at higher prices than during normal blooming season. The objectives of such operations are to: (i) avoid the surplus of in-season cut flowers, (ii) avoid the wastage / spoilage of surplus cut flowers, (iii) avoid the danger of epidemics, (iv) distribute employment throughout the year, (v) increase the farmers’ income, (vi) reduce import and balance of trade, and (vii) satisfy the customers at the time of needs.

It has been hypothesized that, after reaching a ripeness-to-respond stage, and upon receiving proper stimuli (temperature and photoperiod), flowering hormones, known hypothetically as vernalin and florigen, are produced which stimulate the initiation of flower primordium and subsequent blooming.

Plants behave differently with respects to their flowering time. Some flower all year round with either little or great seasonal influences, while others flower during their respective seasons. Flower forcing operations can be done through: (i) adjusting factors which affect flowering, (ii) the use of chemicals, and (iii) mechanical forcing. The factors that affect flowering include photoperiod, temperature and humidity. The chemicals that are responsible for inducing flowers include: (a) fertilizers which are used to retard or stimulate flower initiation, and (b) plant hormones including gibberellins, growth retardants, and growth inhibitors. Mechanical forcing includes pruning, leaf trimming, ringing, low-temperature storage, and breaking dormancy.

Flower forcing of some cut flowers in Thailand is given as examples. These include: Dendrobium orchids, Siam tulip, marigold, lotus, chrysanthemum, jasmine, amaryllis, gladiolus, and roses.

Keywords: Flower forcing, ripeness-to-respond stage, temperature, photoperiod, flower primordium, flower initiation, plant hormones, gibberellins, ethylene, off-season.

1. Introduction

Flower forcing is any operation or treatment to the plant, after reaching its ripeness-to-respond stage, in order to stimulate it to flower, which otherwise it will not, at a specific date (e.g. on Valentine Day), or during off-season periods. These flowering dates or periods may be earlier or later than normal dates or periods of flowering.

1.1 The Goals

The goals of such operation are as follows:

1.1.1 Off-Season Production: Cut flowers that are available during their normal season are plentiful, thus fetching quite a low price. Sometimes, the farmers have to sell their flowers at a loss, otherwise none can be sold. In some cases, harvested cut flowers that could not be sold were left to spoil. Some were
1.2.5 To Increase Farmers’ Income: It is obvious that the farmer’s income will be higher by selling products that are on high demand.

1.2.5 To Reduce Imports and Balance of Trade: It is the florists’ custom to import cut flowers from abroad to satisfy the demands of the customers during certain times of the year when domestic production is not possible, even at a much higher price. Off-season cut flowers, or those produced at certain specific periods, help to reduce imports and balance of trade.

1.2.7 To Satisfy the Customers at the Time of Needs: Generally speaking, the need for cut flowers of the customers is not seasonal, but spread all-year round depending on certain specific occasions. Off-season cut flowers, or those produced at certain specific dates, are to satisfy the customers at the time of their needs.

1.2 The Objectives

The objectives of forcing a plant to flower during off-season or at certain specific dates are as follows:

1.2.1 To Avoid Surplus of In-Season Cut Flowers: Most cut flowers are produced during their respective seasons that have favorable conditions suitable for their production. Thus, large quantities are available and, as a consequence, fetch a low price or even un-saleable.

1.2.2 To Avoid Wastage or Spoilage of Surplus Cut Flowers: Unlike most other products, cut flowers are perishable with time. They are either spoiled or left as waste if not used, or sold.

1.2.3 To Avoid Danger of Epidemics: In-season production of cut flower is subject to a number of insect attacks and disease epidemics due to the presence of favorable climatic conditions for their growth.

1.2.4 To Distribute Employment Throughout the Year: Cut flower production requires intensive labor. During the normal peak season of production, most laborers are engaged in one job or another. Off-season cut flower production helps to distribute employment throughout the year; a benefit to the nation’s economy.
Temperature is particularly effective in flower initiation of bulbs, especially the type in which flower primordia are formed during storage after harvest in the summer but before replanting in the fall. Stored bulbs, e.g. tulips, irises, can be accelerated to flower by exposure to low temperatures (9-13°C), but a high temperature (20 to 30°C) pretreatment is essential if flower formation is to occur at all.

2.3.2.2 Photoperiod Influenced: These are plants whose flowering is influenced by the photoperiod. They are divided into two kinds:

(i) Short-day Plants: These are plants that flower when the day length is shorter than a critical value. Temperature may have influence on flowering; e.g. poinsettia, in which the bracts will not turn red if the temperature is high, although flowers are borne after exposure to short days.

(ii) Long-day Plants: These are plants that flower when the day length is longer than a critical value. Humidity may have influence on flowering; e.g. Siam tulip, in which the initiated flowers will not develop if the humidity is low.

2.3 Flowering Behavior of Plants

Depending on their genetic constitutions, plants can be classified into two groups, namely: (i) those that flower all year round, and (ii) those that flower only in-season.

2.3.1 All-Year Round: There are two types of plants in this group based on how much the season can influence, namely:

2.3.1.1 Little or no seasonal influenced: Flowering occurs all year round with little or no influence of the season. Examples are roses, marigold, chrysanthemum, and heliconia.

2.3.1.2 Great seasonal influenced: The season greatly influences flowering in this type of plant. There is a time when flowering occurs profusely due to favorable climatic conditions, and at the other times, not quite profusely, simply because the weather is not optimum. Examples are jasmine, Dendrobium orchids, etc.

2.3.2 Seasonal: These are plants that flower during specific seasons (i.e. in-season). There are two types of plants in this category, namely:

2.3.2.1 Temperature Influenced: These are plants whose flowering is influenced by the temperature, especially low temperature. Examples are bulbs including amaryllis, tulip, daffodil, narcissus, etc. which will flower upon exposure to low temperatures.

2.3.2.2 Photoperiodic Influenced: These are plants whose flowering is influenced by the photoperiod. They are divided into two kinds:

(i) Short-day Plants: These are plants that flower when the day length is shorter than a critical value. Temperature may have influence on flowering; e.g. poinsettia, in which the bracts will not turn red if the temperature is high, although flowers are borne after exposure to short days.

(ii) Long-day Plants: These are plants that flower when the day length is longer than a critical value. Humidity may have influence on flowering; e.g. Siam tulip, in which the initiated flowers will not develop if the humidity is low.

3. Forcing Operation

3.1 Adjusting Factors Affecting Flowering

3.1.1 Temperature: For low temperature-requiring plants, the temperature can be adjusted by keeping the plant parts, mostly bulbs or seeds, in the refrigerator or freezer.

3.1.2 Photoperiod: Photoperiod can be adjusted either by providing supplementary light from artificial sources, such as tungsten bulbs and fluorescence lamps, to prolonging the duration of day length, or keeping the plants in a dark room to shorten the duration of day length. There are two main aims of adjusting photoperiod:

3.1.2.1 To induce flowering by giving optimum photoperiod: By providing supplementary light to a long-day plant to exceed the critical value, flowering will be induced; e.g. peppermint requires at least 16 hrs of day length to flower, whereas the maximum day length in Thailand is 14.30 hrs;
thus a little over 1.30 hrs of supplementary light is needed to induce peppermint to flower in Thailand.

3.1.2.2 To keep the plant in non-inductive cycle so that it will not flower: By providing supplementary light to a short-day plant to exceed the critical value, it will not flower, but remains in the vegetative phase; e.g. chrysanthemum, a short-day plant, requires 14.30 hrs or less to flower, whereas the day length in Thailand is less than that, thus it will flower all-year round even from a small plant, making it non-productive, and only small flowers are produced. By providing supplementary light to exceed 14.30 hrs of day length, it will not flower, until such time that is optimum, light is cut off, and it will flower profusely.

3.2 Chemical Flower Forcing

Four types of chemicals affect flowering, namely fertilizers, plant hormones, ethylene, and other chemicals.

3.2.1 Fertilizers: Certain fertilizers affect the C/N ratio of the plant, which in turn affects flowering. The broader C/N ratio, i.e. higher C, will induce flowering, while the narrower C/N ratio, i.e. lower C, will keep the plant in vegetative phase. Adjusting fertilizer formula can be used to retard or stimulate flowering.

3.2.1.1 Retarding flowering: This can be done by providing fertilizers having high amounts of N to the plant. Watering should also be provided so that N will be readily absorbed by the plant.

3.2.1.2 Stimulating flowering: This can be done by giving fertilizers having low amounts of N, and reducing watering. Other chemicals that help to fix N to a bound form can also stimulate flowering.

3.2.2 Plant Hormones: There are two main types of plant hormones what affect flowering, namely:

3.2.2.1 Gibberellins: At least 50 gibberellins have been discovered in fungi and plants. All could properly be called gibberelic acids, or GA. Gibberellins have the unique ability among plant hormones to stimulate extensive growth of intact plants. It has been demonstrated that gibberellins can substitute for the long-day requirement in some species, and has an interaction with light. They also overcome the need some species have for inductive cold period to flower (vernalization). It appears that the formation of flowers caused either by long days or by cold periods might normally depend upon the buildup of endogenous gibberellins during these periods, because the gibberellin content on some affected plants increase following these treatments.

3.2.2.2 Growth retardants: These are a group of synthetic chemicals that inhibit stem elongation and cause overall stunting. They do so in part because they inhibit gibberellin synthesis. These include: Phosphon D, Amo-1618, CCC or Cycocel, and Ancymidol.

Growth retardants (e.g. CCC) promote initiation of floral primordium by reducing endogenous GA level, or antagonizing its inhibitory effect on floral initiation.

3.2.3 Ethylene: Ethylene has been popularly known to induce flowering in the pineapple. A sprinkle of acetylene, a precursor of ethylene, on top of the pineapple plant, is quite effective in inducing the pineapple plant to flower. An ethylene-releasing substance, called ethephon or Ethrel, is commercially available. The induction of flowering in the mangoes and the bromeliads by ethylene is unusual, because the gas inhibits flowering in most other species.

3.2.4 Other Chemicals: There are a number of other chemicals that are used to induce flowering, especially of fruit trees. These include the explosive potassium chlorate and its related compound - sodium chlorate, potassium nitrate, thiourea, paclobutrazol (commercially known as Cultar), etc. which, when applied as soil drench or leaf spray results in flowering of many fruit trees.

3.3 Mechanical Flower Forcing

3.3.1 Pruning: Pruning helps to broaden the C/N ratio, thus stimulating flowering. This can be seen in the case of bougainvilleas in
which flowering takes place soon after pruning, with the application of proper fertilizers and watering. Other flowers, such as roses, also need pruning for flowering induction.

3.3.2 Leaf Trimming: Leaves may provide inhibitor to flowering, like in the case of jasmine. Thus, cutting off some leaves or portion of a leaf helps to induce flowering.

3.3.3 Ringing: Ringing helps to broaden the C/N ration, thus stimulating flowering. This is obvious in the case of fruit trees in which ringing induces flowering and fruiting.

3.3.4 Low-temperature Storage: Many plants are promoted to flower by low-temperature storage. This can be done by keeping the plants, usually the bulbs or corms, in the refrigerator for a period of time before they are taken out for planting.

3.3.5 Breaking Dormancy: Seeds and buds of some plants are in dormant stage, i.e. no growth at all, for a period of time. Breaking dormancy can be done by exposure to low temperature, or treatment with chemicals and gibberellins. The latter, i.e. gibberellins, are more commonly used in association with flowering. Applied gibberellins break dormancy of many cold-requiring seeds and induce flowering of many cold-requiring plants.

4. Forcing of Some Cut Flowers in Thailand

There are quite a few kinds of cut flowers commercially grown in Thailand that can be forced to flower at certain specific dates or off-season periods. These are:

4.1 Dendrobium Orchids (Dendrobium spp.)

4.1.1 Flowering Behavior: All-year round, but more profuse during the rainy season and less profuse in the winter (which happens to be the time when the demand is high).

4.1.2 Operation: Pinch off flower buds in August/September (to save nutrients for later blooming), then apply special fertilizer (high in P & K) during October/November, 3 to 4 times to induce blooming from November onwards for the December/January harvests (Chomchalow 1972; Technology Transfer Forum1997).

4.2 Siam Tulip (Curcuma alismatifolia)

4.2.1 Flowering Behavior: Seasonal, flowers produced during the rainy season (June to August), requiring long-day condition. No flower develops after September when short-day condition commences. Above ground parts wither and die down, and rhizome enters dormancy period until next rainy season.

4.2.2 Operation: Provide additional light to break dormancy. Most effective is providing 3 hrs of light in the middle of the night. Start soon after day length is shortened (21 September). In this way, the plant will continue to produce flowers all the way to New Year's day, provided enough humidity and nutrients are given.

4.3 Marigold (Tagetes erecta)

4.3.1 Flowering Behavior: Being a day-neutral plant, it flowers all-year round. It normally takes 60-70 days from seeding to harvest.

4.3.2 Operation: Timing of flowering can be made by fixing the date of seeding 60 to 70 days ahead of the harvest date. The recommended period is 65 days. For example, if the flowers are to be harvested for New Year's, the seeding should be done on 27 October, transplant on 6 November, pinching on 22-24 November, flower bud emerges on 5 December, and blooming 25 December to 5 January (Muangnao 1997).

4.4 Lotus (Nelumbo nucifera)

4.4.1 Flowering Behavior: All-year round, but needs standing water.

4.4.2 Operation: Operation to induce flowering of the lotus plant varies according to the season (Buri-ngarm1997).
4.4.2.1 Winter Season: Low temperature during the winter reduces the amount of blooming. Thus, it is recommended that the level of water be reduced to 50 cm in order to raise water temperature. In this way blooming will be the same as the summer, both in terms of amount and size of flower.

4.4.2.2 Dry Season: High temperature during the summer speeds up the growth of the lotus plant and the blooming time, but flower size is small. Thus water level should be raised up to 75 cm (from original 50 cm level in the winter). In this way, water temperature will be reduced and the amount of bloom and size of flower will be maintained.

4.4.2.3 Rainy Season: Due to the addition of rain water which may increase the level of water, it is recommended that the level of water be maintained at 50 cm in order to accommodate additional rain water. Blooming will be maintained as normal.

4.5 Chrysanthemum (*Chrysanthemum morifolium*)

4.5.1 Flowering Behavior: It is a short-day plant, with critical value of 14.40 hrs. Thus, it will bloom all-year round under conditions in Thailand having the maximum day length of 13.30 hrs on 21 June, the longest day of the Northern hemisphere.

4.5.2 Operation: Extend day length by giving artificial light after sunset for about 3 hrs during early stage of growth to keep seedlings in the vegetative stage until one month of the planned harvest date. For example, if the planned harvest date is New Year’s, cutting should be made in September and transplanted to the growing plot when rooting occurs. Keep the seedlings under light regime of more than 14.5 hrs by providing artificial light (100 w incandescent bulb) until 1 December (seedlings should be at least 30 cm high). They will bloom on 1 January.

However, as chrysanthemum blooms profusely during the period of low temperature, which commences in December, it fetches a low price in the market even during the opportune time of Christmas or New Year’s. Thus, some farmers avoid producing flowers during such a period, but move it to the summer. The problem is the temperature during the summer is quite high, and not optimum for chrysanthemum growth. The most suitable place of production of chrysanthemum flowers is on the highlands of northern Thailand where temperatures during the summer are around 16-20°C. The same principle of flower forcing is applied, but in this case the day length in northern Thailand may be lower than the critical value of certain varieties. As practiced in Doi Phu Kha of Nan Province, a black cloth is used to completely cover the plant house from 16.00 to 08.00 hrs for 30 days after the cuttings have been exposed to long-day condition (to be supplemented with artificial light) (Manichote 1997; Public Relations Section 1997; Yodsri 1997).

4.6 Jasmine (*Jasminum sambac*)

4.6.1 Flowering Behavior: All year round, but very profuse during the rainy season, and scarce during the winter.

4.6.2 Operation: To produce jasmine for winter-season harvest, the following operations are recommended (Suisuwan *et al*.,1976).

(i) One month before the planned date of harvest, stop watering for 2 - 3 days until the plant show a sign of wilting.

(ii) Prune the plant to a round shape so that blooming will emerge from mature branches when induced in Stage (iii). In this way the blooms will be of large size and healthy as they receive full sunlight.

(iii) Apply balance fertilizer (e.g. 15-15-15) at the rate of 30 g/plant and water heavily. Keep watering normally every day. Flower buds will emerge within ten days and blooming occurs within 25-30 days after pruning.

4.7 Amaryllis (*Amaryllis spp.*)

4.7.1 Flowering Behavior: All-year round, although depends on the availability of bulbs which are available from the Netherlands in the summer (June onwards). After the bulb is planted, it takes about one month for the
flower primordium to develop into full bloom ready to be harvested as cut flower.

4.7.2 Operation: Keep the bulb in the vegetable compartment of the refrigerator (4°C) for at least two months. Plant the bulb one month prior to the planned date of flowering.

4.8 Gladiolus (Gladiolus hybridus)

4.8.1 Flowering Behavior: All-year round, provided the weather is optimum (requires cool climate). Blooming occurs 90-100 days after planting.

4.8.2 Operation: Operation to induce flowering of the gladiolus plant varies according to the climate, namely:

4.8.2.1 In Cool Climate: Preheating corms before planting for two weeks at 27-32°C will force such corms to flower early.

4.8.2.2 In Warm Climate: Soaking corms in GA solution (10 - 25 ppm) before planting will accelerate flower by hastening differentiation of flower primordia.

4.9 Roses (Rosa hybrids)

4.9.1 Flowering Behavior: All-year round, but more profuse in cool season.

4.9.2 Operation: For blooming during: (i) Christmas - New Year’s, and (ii) Valentine’s Day, the following procedure is suggested:

(i) Cut the branches in November. It takes 43 days after pruning to flowering. This will stimulate flowering during Christmas - New Year’s. Cutting the flowers on 23 December will further stimulate flower bud initiation to bloom on 10 February. It takes 49 days after cutting!

(ii) Pinch (i.e. cut only the tip off) instead of pruning as in (i) above on 10 November for 23 December harvest. This operation automatically stimulates flower initiation for harvest on 10 February. The following operations should be followed:

- Do not pinch flower buds which will bloom in 30 days on 10 Nov. Allow them to bloom for 10 December harvest.

- Do not pinch flower buds that are still very small.

- Pinch all other branches, including those flower buds that are not healthy, deformed, etc. Do not pinch too far down to healthy leaves, unless they are water sprouts that should be cut off from the base.

5. Discussion

Cut flower production is a growing business in most Asian countries as the result of higher per capita income of people. Technology for production is well known and has been utilized to the maximum in many countries. As a consequence, cut flowers are commercially produced in larger quantities in these countries resulting in surpluses during the normal periods of blooming, the end result of which is a lower price for cut flowers. On the other hand, such prices are much higher during the periods of needs such as certain special occasions, or off-season.

The technology of flower forcing has been accumulated and placed on a trial-and-error basis for a few cut flowers, many of which have achieved considerable success in Thailand. However, due to erratic climatic conditions, such practices will have to be modified to avoid the risk of obtaining flowers prior to, or after the required period.

Another important factor influencing the production of cut flower availability at certain specific times or off-season is the use of chemicals. As happens in forcing off-season fruits like longan, mango, durian, etc., the use of chemicals has been blamed by the environmentalists. The reason given is that such a treatment creates pollution in the soil and water, as well as deteriorating the physical conditions of the soil, if such chemicals are used in high concentrations and/or for prolonged periods. Thus, the use of chemicals should be minimized as much as possible, particularly those that are used on the soil.

The use of mechanical methods like pruning, grafting, keeping reproductive parts in low temperatures, or adjusting water availability or levels, does not cause any
environmental problems. The only problem is its sensitivity to various climatic factors such as rainfalls and temperatures, which are quite erratic during certain years.

Unlike fruit trees in which off-season varieties of many fruit species are available as the result of mutation of ordinary type to off-season type, known in Thai as ‘Thawai’, cut-flowering plants, unfortunately, do not have any ‘Thawai’ variety, at least at the present time, simply because none has occurred, or has never been recognized and selected for use by the farmers. This is one obvious disadvantage of cut-flowering plants over fruit trees.

6. References
(All references are in Thai)


