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A REVIEW ON CUT FLOWERS AND POST-HARVEST TECHNOLOGY

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Abstract: Cut flowers are an important part of commercial floriculture and also bring an export income in many ways through global market. Vase life and longevity of cut flowers depend upon different varieties and their freshness varies upon preharvest, harvest and post-harvest conditions. The post-harvest factors must be considered to prolong vase life to obtain desirable quality of cut flowers. In this review, senescence and post-harvest physiology of cut flowers and various pre harvest, harvest and post-harvest factors affecting the life and quality of cut flowers is discussed. Also, solutions are provided along with examples to increase the vase life of cut flowers

Index Terms: **Ethylene, Senescence, Vase Life, Post-Harvest Physiology, Pre-Harvest Factors.**

I.INTRODUCTION:

1.1 What Are Cut Flowers?

Cut flowers are any flower with a stem or branch that has been cut at a certain length for a specific purpose, including blossoms, buds, and leaves. In India, commercial floriculture is a relatively new concept (Singh, 2002; Bhattacharjee and De, 2003).

1.2 Cut Flower Market At Global Level

Floral market is seen as a worldwide market that connects countries. In India, commercial floriculture is a relatively new concept. Government scrutiny, entrepreneur zeal, and rising demand in domestic and international markets have resulted in unparalleled growth (Singh, 2002; Bhattacharjee and De, 2003). The cut flower market is entirely based on customer demand. Cut flowers must be exported to the florist market within a few days or a week of harvest. As a result, it's critical to comprehend the plants' physiological requirements after harvest. It will assist the grower in taking the necessary steps to ensure a satisfactory product (Onozaki, T and Azuma, M, 2019). The ever-changing nature of human emotion, the dynamic growth of the society we live in, and the scenario that governs our lives are the key catalysts for the consumer-driven cut flower market.

Globalization of the economy encourages increased consumption of floricultural products and, as a result, increased flower consumption per capita. With rising personal income and economic globalization, there has been a great increase in demand for floricultural products. Flowers are becoming more popular in both developed and developing countries. With the globalization of trade and improved economic development, India has become one of the top consumers of cut flowers. In terms of total flower consumption as well as average per capita consumption, Japan has emerged as one of the leading consumers of cut flowers. The United States of America, Japan, West Europe, East Europe, South Korea, Thailand, and Indonesia are major importers. While the Netherlands (56.5%), Colombia (14.1%), and Israel (4.2%), as well as Kenya, Thailand, Zimbabwe, Ecuador, and others, are key exporting countries, India's part is relatively small, accounting for only 0.3 present of global cut flower exports (Kras and Fisher, 1999).

II.SENESCENCE AND POST-HARVEST PHYSIOLOGY OF CUT FLOWERS

Senescence refers to the processes that occur after a plant reaches physiological maturity and result in the death of the entire plant, organ, tissue, or cell (Watada *et al*, 1994).

Many changes occur within the membranes during flower senescence, including an increase in ethylene production, a loss of differential permeability that leads to greater ion leakage and a reduction in weight due to excessive water loss. Flowers die as a result of the loss of cell components. Petal growth necessitates two quantitative mechanisms (Van Doorn, 1997). The cell wall must be able to expand, and water must be able to enter the cell. Cells in abscising petals may lose water prior to abscission during senescence, resulting in a modest increase in cell leakiness (Stead and Moore, 1983). Wilting is the first symptom of petal senescence in some species, followed by a major rise in leakage of inorganic iron, reducing sugars, amino acids, and anthocyanin's, which could be related to loss of tonoplast semi-permeability (Bieleski and Reid, 1992). The rate of transpiration through open stomata of leaves determines the vase life of cut flowers (Van Doorn, 1997; Nobel, 1991; Tenhunen et al, 1987; Raschke, 1989).

2.1 Petal Senescence

Petal senescence is accompanied with morphological, biochemical, and biophysical degeneration. The protein content decreases, increased activity of proteases, the fluidity of lipids in membranes decreases, the rate of respiration rises (Van Doorn and Stead, 1997), an increase in the production of ethylene occurs, chemical and physical changes in senescing petals' microsomal membrane lipids (Bartoli *et.al*, 1996) due to effects of petal senescence.

2.2 Ways to Retard Senescence and Extending Vase Life:

De & Bhattacharjee (2000) suggest that the following methods for extending the vase life of cut flowers: Harvesting flowers early in the morning or late in the afternoon when they are at the right stage of development. Harvested flowers are hardened in demineralized water with biocides and acidifiers. Pre-cooling of flowers in a cold storage without sealing or open boxes at desired temperatures immediately after harvest. Short-term impregnation of cut floral bases with high concentrations of silver nitrate, nickel chloride, or cobalt chloride. Forcing cut flowers to open and improve color by pulsing them with a high concentration of sucrose or germicides for a brief time. Using sucrose, germicide, and hormone chemicals in bud opening solutions for big cut flowers at the immature bud stage. Carbohydrates, germicides, growth hormones, ethylene antagonists, mineral salts, and organic acids can be kept in holding solution mixes with wholesalers or retailers to maintain flowers until they are sold, or with customers to use in the vase constantly. Recent approaches, such as low-dose gamma ray therapy of clipped stems, encourage the opening of blooms, particularly in roses. Corrugated cardboard boxes should be used to carry flowers. According to the grades of produce, the size of the box should be such that it secures the product properly.

Longer vase life is linked to a lower respiration rate (Bhattacharjee, 2003). The conventional strategy for delaying senescence in the flower industry is to inhibit respiration by lowering the storage temperature. The cut flowers of 'Raktagandha' roses that were exposed to cold storage for 24 hours at 4 degrees C showed the lowest rate of respiration immediately after treatment. The rate of respiration was considerably lower after 45 minutes of ice-cold water spray therapy compared to the untreated control group (Palanikumar *et al*, 2000). After wet and dry storage at 4 degrees C after harvest, the rate of respiration of cut roses reduces (Bhattacharjee, 2003).

At the senescence stage, as influenced by pre-cooling, pulsing, and packaging, prolonged vase life was related with maximal starch and total phenol content and minimum TSS (total soluble sugars) and TFAA (total free amino acids) in the petal tissues. Total starch, TSS and total phenols were dramatically reduced after pre-cooling with cold water spray for 45 minutes, pulsing with DMSO up to 2% for 15 minutes, and wrapping with various packing materials. Additionally, utilizing butter paper as a packaging material for 6 hours resulted in the longest vase life with the lowest TFAA on the third day and at the senescence stage (Mwangi *et al*, 2003).

2.3 Ultra structural Changes during Senescence

There are two central processes affecting cut flower's quality are photosynthesis and respiration (Wills et al., 1998) doubt. Ethylene causes sepal drying, abscission, floret abscission, in-rolling of petals or corollas, wilting, and even color changes as a result of leaf and petal senescence (Davies, 1995). Also, depending on whether or not an ethylene and respiratory peak occurs during petal senescence, flowers are classified as climacteric or non-climacteric. In climacteric species, ethylene production is central to petal senescence, which is induced in response to ethylene, implying that it is involved in both the initiation and regulation of senescence, whereas ACC synthetize and ACC oxidase increase dramatically prior to the onset of senescence, which does not occur in non-climacteric species (Williams *et al*, 1995).

The leakage of various substances, including amino acids, carbohydrates, K+ ions, and total electrolytes, increases dramatically with senescence (Borochov and Faragher, 1984; Faragher *et al*, 1986). Membrane lipids, including phospholipids and their associated fatty acids, demonstrate a continual progressive reduction with the commencement of petal senescence (Borochov and Woodson, 1989. Total starch content of petals in 'Raktagandha' cut roses has a tendency to increase on the third day in the vase over the first day, then decline at senescence. Longer vase life was associated with higher starch content, TSS content, RS content, and total phenols content; and reduced TFAA concentration in petals (Vidhya Sankar, 2001). Hydrolysis of sucrose took place virtually exclusively in petals (Paulin and Droillard, 1982). Protease activity in petals and leaf tissues of 'Raktagandha' rose cut flowers treated with sucrose pulse for 24 hours followed by wet storage at 3 °C is reduced. Longer vase life of cut roses was linked to lower enzyme activity, which was modified by pulsing treatment (Shiva *et al*, 2002).

III. Pigmental Changes In Cut Flowers

Color fading and discoloration are crucial factors in deciding how long cut flowers will last. Carotenoids and anthocyanin's are two important pigments that contribute to floral quality. Many of the yellow, orange, and red pigments are carotenoids, but anthocyanin's and related chemicals (flavonoids) are responsible for the red, purple, and blue colours in most flowers (Tyrach, 1997), which are related to pH. Colour variations in sensing petals are also influenced by changes in the pH of the vacuole. Anthocyanin's are red at a more acidic pH (7) and blue at a higher pH (>7), often obscuring carotenoids and Chl. This results in a condition known as 'blueing,' in which the color of the skin changes from red to blue as it ages (Wills *et al.*, 1998). The breakdown of protein and the release of free ammonia can be blamed for the blueing of red blooms as they age, as well as the rise in pH. The presence of organic acids such as aspartic, maleic, and tartaric acids may cause a fall in pH in some flowers. The accumulation of oxidation products of polyphenols and an increase in anthocyanin content at low temperatures have been linked to the petal blackening of "Baccara" roses. When cut roses were treated with a preservative solution comprising 2% sucrose, 250 ppm 8-HQC, 500 ppm citric acid, and 25 ppm silver nitrate, Gao and Wu (1990) discovered an increase in anthocyanin loss. Son *et al.* (1997) discovered a beneficial effect. When treated with a solution of 2% sucrose + 200 ppm 8-HQC + methionine, Son et al (1997) observed a good effect on retaining petal color.

IV.PRE-HARVEST AND POST-HARVEST FACTORS

Cut flower's potential useful life is influenced by a number of pre-harvests, harvest, and post-harvest conditions. The environment, which has aided the crop's growth, also has a role to play. Several pre-harvest elements such as light, temperature, soil, nutrition, relative humidity, season day, irrigation, pests and diseases, have a significant impact on the post-harvest life of cut flowers and other ornamental plants. The keeping quality of cut flowers is influenced by the season, harvest time and stage, post-harvest treatments, and a variety of other factors. Maintaining freshness and turgidity, as well as increasing vase life and flower quality, are all important aspects of flower post-harvest management.

4.1 Light

Another physiological function that is regulated by light includes chlorophyll production, phototropism respiration, and stomata opening. The majority of commercial flowers require a lot of light (3,000-8,000 f.c). Carnations and chrysanthemums have a longer vase life when exposed to high light intensity than when exposed to low light intensity. Low light intensity promotes excessive elongation of flower stems and delays stem hardening, resulting in roses with a 'bent neck' and carnations and gerberas with stem bending (Halevy and Mayak, 1979). Excessive light is also damaging and degrades the quality of the flowers. The color of petals is also affected by the intensity of light. The availability of carbohydrates in the surrounding tissues determines the color intensity of the petal (Halevy and Mayak, 1974). Cut flowers with a higher concentration of stored carbohydrates have a longer vase life (Halevy and Mayak, 1979). Light compensation points (LCP), light intensities required for photosynthetic saturation and respiration intensities of plants originating from sunny habitats. Plants should be grown in the appropriate amount of light. Plants having a lower LCP thrive in reduced light environments and are better adaptable to changing climates. It's best to grow foliage plants in the shadow to help them adjust to lower light levels. In low-light situations, white florescent lamps can be used to supplement the foliage plants.

4.2 Temperature

The vase life and quality of cut flowers are reduced when the temperature is higher in the field. Flowers stored carbohydrates are quickly exhausted during respiration at higher temperatures, causing the plant to transpire more quickly. Because to inadequate conversion of chloroplasts to chromoplasts, the rose cultivar 'Dr. Verhage' develops a greenish color when grown at a lower temperature (15°) (Halevy and Mayak, 1979). When rose cv. 'Carol' and 'Dr. Verhage' are cultivated at a higher temperature, they create very pale blooms, but when clipped at the bud stage and preserved in a sucrose solution, they generate normal color (Halevy and Mayak, 1974). The temperature at night has a significant impact on carnation growth and development. Lanky growth occurs at temperatures below 9° Celsius. For highest grade carnation flowers, a day temperature of 16° C has been discovered to be ideal (Celikel and Karacaly, 1991). In 1991, Boyle suggested using a combination of temperature and photoperiod treatments to shorten flowering days while increasing flower numbers and phylloclade per plant. Many potted plants benefit from a drop in temperature during their last growth phase because it improves their color and quality. At very low or very high temperatures, *Ficus benjamina* and *Ficus lyrate* are prone to leaf shedding (Poole and Conover, 1982).

4.3 Humidity

In a humid environment, fungal and bacterial infections can develop, causing damage to cut flowers during storage and transportation. For all floral crops, a relative humidity of roughly 90-92 % is normally suggested. On plants with thin leaves or leaflets, low light humidity can cause browning of the leaf edge. Damaged flowers lose water quickly and produce a lot more ethylene than healthy flowers. High humidity can keep waterborne contaminants in a state where they can be absorbed more easily through the cuticles or stomata. According to Mortenson and Fjeld (1995), raising moisture from 65 to 85 percent has little effect on rose vase life, while increasing it to 90 percent dramatically reduces it. The number of lesions during storage and transportation is determined by the air humidity inside the glass house and global radiation outside the glass house (Kerasies and Frinking, 1996). As a result, it is critical to reduce air humidity by heating and ventilation the glasshouse.

4.4 Pest and Diseases

Plants and flowers of export quality should be free of pests and illnesses. Both pests and illnesses cause damage to the leaves and blossoms, lowering the quality. They cause wilting and ethylene production in tissues that have been damaged by them (Nowak and Rudnicki, 1990). Botrytis, Alternatia, Puccinia, Cryptos Porella, Actinonema, and Diplocarpon are microbes that increase the generation of ethylene in plant tissues (Aarts, 1957). Before the plants are delivered from the nursery, a preventative spray against serious diseases like powdery mildew and botrytis rot is required. Placing the materials in a low-humidity environment can help to prevent diseases like botrytis rot (Noordegraaf, 1995).

V. EFFECT OF PGR'S IN SENESCENCE

5.1 Ethylene

Ethylene, a phytohormone, is vital in the regulation and coordination of climacteric floral senescence. During floral growth, opening, and withering, ethylene evolution spikes dramatically. Following that, ethylene production declines and remains constant. There are three separate phases of ethylene production: (1) a low steady rate, (2) an accelerated rise to maximal emanation and (3) a final phase in which production is reduced. Short-lived rose blossoms enter the second phase earlier than long-lived rose flowers (Mayak and Dilley, 1972). According to Nair *et al* (1991), there is a link between senescence visual changes and ethylene production in Dendrobium cv. 'Pompadour' blooms. A significant rate of ethylene synthesis has been discovered at senescence in Vanda cv. 'Miss Joaquim' and Paphiopedilum flowers, while higher quantities of ethylene have been detected in floral buds of Dendrobium cv. 'Jacquelyn Hawaii' than open florets and senescence florets. The style that causes petal wilting produces endogenous ethylene; the carnation style produces roughly 40-50 percent of the overall ethylene. The petals produce a similar amount, with the majority of the production concentrated at the petal's extended base.

Based on the presence or absence of ethylene production linked with petal senescence, Halevy (1986) classed flowers as climacteric or non-climacteric. In cut roses, ethylene production is minimal at the bud stage, progressively increases as the outer petals open, peaks at full opening and then declines. The auto-catalytic synthesis of ethylene by senescing climacteric flower petals (Woodson *et al*, 1985). Long-lasting flowers have a larger concentration of endogenous ethylene than short-lived blossoms (Zhang *et al*, 1991).

5.2 Cytokinin

The amount of Cytokinin in rose petals declines with age, and it is smaller in short-duration cultivars than in long-duration cultivars. Cut carnations' senescence is delayed by cytokinin (Mayak and Kofranck, 1976). According to Eisinger (1977), Cytokinin are natural anti-senescence agents, and their decline could be a trigger for increased ethylene synthesis. ACC oxidase activity in the petals is likewise reduced by this cytokinin. According to Mayak and Halevy (1974), kinetin treatment slows the loss of dry weight of mature flowers (Paull and Goo, 1985).

5.3 Gibberellins

GA3 is involved in the regulation of carnation petal development. The use of GA3 slowed the ageing of isolated carnation petals. GA3 extends the life of clipped blooming shoots of alstroemeria (Van Doorn and Woltering, 1991).

5.4 Auxin

Auxin is a hormone that regulates the senescence of poinsettia blooms. It prevents senescence by causing the production of peroxidase. IAA causes senescence in carnations by increasing the time and amount of ethylene production, according to Wulster *et al* (1982). Auxin triggers post-pollination events in orchids, such as folding, withering, and anthocyanin production, according to Arditi (1994).

5.5 Abscisic Acid

Flowers' senescence is thought to be aided by the presence of Abscisic acid (ABA). By sealing the stomata on the leaves, it minimizes water loss from the blooming branch of roses and delays flower senescence (Haley *et al*, 1974a). According to Mayak and Halevy (1980), ABA accelerates the physiological stages linked with ageing and enhances tissue sensitivity to ethylene production.

VI.Conclusion

The importance of quality, product range, certification, and manufacturing sustainability has risen in recent years. Pre-harvest conditions influence the potential life of cut flowers. Pre-harvest handling of cut flowers will result in better appearance and longer life for cut flowers and foliage. Long-lasting flowers mean less losses throughout the handling process. In the end, this means a better product for the client. A series of events occur during senescence, including membrane alterations, discoloration among the petals, and an increase in ethylene production. Ethylene is necessary for the senescence of cut flowers.

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