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Post-harvest technology of ornamentals

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Abstract

Flowers and ornamentals are the integrated part of human life but it is highly perishable in nature, without post-harvest management it can't store long time. So, post-harvest management is the important part of floriculture sector. Pre-harvest, Post-harvest and Harvesting (Stage of harvesting, Time of harvesting, Method of harvesting) is strongly related to self-life of flowers and ornamentals. Flowers and ornamentals should be harvested at a proper time, otherwise loss of quality and self life. Some example is Rose (Tight bud stage), Marigold (Fully opening Stage), Orchid (3 to 4 days after full opening of flower), liliium (Bud colour show red) and others. Major advantage of post-harvest management is throughout the year flower supply, Farmer can get more profit, Crops spoilage is very low and more employers also involve under post-harvest industry but, some physiological disorder also found during post-harvest condition such as; calyx splitting of carnation, Bent neck of rose, Bud drying of lily, Sleepiness of carnation, Topple of gladiolus, Petal Discoloration of rose etc. After harvesting of flowers and ornamentals different types practice should be needed for prolong self life and avoid post-harvest disorder, such as; precooling, Conditioning, Impregnation, Pulsing, Grading, Packaging, Transportation, Storage. Mass amount of store flowers and ornamentals can't consume every day. So, need export to other state or other country but, without Agri-export zone how it possible. The concept of Agri-Export zone takes a comprehensive look at a particular produce/product located in a contiguous area for the purpose of developing and sourcing the raw materials, their processing/ packaging, leading to final exports. The main object of Agri export is boosting agricultural exports from India. Centre Government of India has sanctioned 60 AEZs comprising about 40 agricultural commodities. AEZs are spread across 20 states in the country.

Keywords: Post harvest, flowers, ornamental and agri-export zone

Introduction**1. What is harvesting?**

Harvesting is a process of gathering ripe crops from field. It is depend of distance of the market and which purpose use of the crop. Harvesting is depending upon 3 factors, such as:-

1.1 Stage of harvesting: Generally, the flowers remain in turgid condition for long time if harvest at the proper stage of development. Flowers cut at an advanced stage have a shorter longevity than younger ones. The optimal stage of flower development for harvest depend on plant species, varieties, season, the distance to market place and consumer preferences. Flowers are generally harvested at the immature stage for long distance markets, and at advanced stage for local market. Flowers cut too immaturely do not open properly; those cut at too advanced a stage wither quickly. Vase life of cut roses cv. "Angelique" and "super star" can be lengthened, if buds are harvested at the stage when two petals out curve from the tip. The bud of rose cv. "Sonia" harvested at the stage when one petal was unfurling gave the maximum flower diameter (6.25cm) compared to (4.25cm) in the case of flower harvested at the tight bud stage. It has been found that rose cut at the tight bud stage had reduce flower opening capacity when place in the vases at cool room temperature. The cut of flowers should be kept in holding solution of STS 0.2 mM + 8 HQC 300 ppm + sucrose 2 percent (Khalid and Elhindi, 2012) [8]. It was also noticed that there was progressive rise in contents of TSS and TFAA from the less mature flower buds. Red and pink roses are harvested for direct scale when first two petals are beginning to unfold and the calyx is reflexed below a horizontal passion. Yellow cultivar of rose at a stage slightly later than the red and pink cultivars.

1.2 Time of Harvesting: Optimum time of harvest depends upon the type of plants and climatic conditions. It is advisable to harvest flowers when temperature is mild because high temperature cause repaid respiration rate and excessive water loss. Flower should be harvested

in the morning or in the evening. In the morning flowers remain turgid due to transpiration at night. However flowers cut in the morning may be susceptible to fungi infection. Similarly flowering stems retain a high amount of stored carbohydrates if cut in the afternoon. Flower like rose (<https://www.almanac.com/plant/roses>) chrysanthemum and gerbera are recommended for harvesting in the morning because they transpire water quickly. Halevy and Mayak, (1979) [7] reported that rose harvested at the afternoon had a longer post-harvest life than those cut in morning. These effects have been attributed to higher level of carbohydrates from photosynthesis during the day time and translocation and respiration during night causes reduction level of carbohydrate in the flowers cut in the morning.

1.3 Method of Harvesting: Flower should be harvested in the right method, depend upon the category of the stems. Sharp tools or secateurs should always be used to detach the stem of flowers from the mother plants. Angle of the cut should be slanting and the stem should not be crushed during harvesting, especially hard wood stems. Such type of harvest exposes the maximum surface area to absorb water at a rapid rate. The nature of cut, however does not affect the herbaceous stems which can absorb water through epidermal tissues also. It is better harvest the stems which are less hardened. The hard and highly lignified stems lying very close to the soil should not be cut as they showed lesser vase life due to lower water absorption. For example stems of chrysanthemum should be harvested at least 10 cm above the ground level.

2. Harvesting-index

Harvesting index mean harvesting of the crops at the right stage, that consumer are preference. Different flowers have different harvesting stage.

Table 1: Harvesting stage

Flowers	Harvesting stage
Rose	Tight bud stage.
Marigold	Fully opening of the flower.
Gladiolus	1-5 lower florets show colour.
Chrysanthemum	When outer florets fully expanded.
Jasmin	Fully open flower.
Orchid	3-4 days after full opening of flowers.
Carnation	Paint brush stage.
Tuberose	Lower pair of flower buds just burst.
Gerbera	Flower open but outer 2 rows show shedding of pollens.
Dahlia	Fully open flower.
Anthurium	Spadix fully develops.
Amaranthus	½ florets open on spike.
Alstroemeria	4-5 florets open on spike.
Lilium	Bud colour show red.
China aster	Fully open flowers.
Tulip	Half colour buds stage.

3. What is post-harvest technology?

Post-harvest technology is a process which is used after harvesting of the crop proper management should be done without physiological and biological damage. That result freshness of crops for long time.

4. Advantage of post-harvest technology

1. Freshness of crops for long time.
2. Seasonal crop can be available throughout the year.
3. Farmer can be get more profit.
4. Economically crop spoilage very low.
5. More employers also are added

5. Major problem post-harvest life in ornamentals

5.1 Bent neck: It is very common problem of roses and is due to following reason-

- a. Water deficiency in the neck tissue which is controlled by transpiration rate, the rate of water uptake and the ability of the different organs on the cut flower shoot to complete for water (Van Doorn, 1997)^[13].
- b. Appearing of plugging materials like Pectin, cellulose and microbes.
- c. Extreme temperature during shipping or storage.

5.2 Limp Neck: It is a type of disorder in roses caused by water stress in the area just the below the flower head. The affected flower bud bends due to weight of the top. Insufficient stored energy of flower head may be one of the reasons.

5.3 Bud drying: It is the common problem of Asiatic hybrids lilies, the apparent desiccation and shriveling of flower bud followed by abscission is a common problem. This problem is solved by STS pulsing.

5.4 Calyx Splitting: Calyx splitting is mainly found double type of carnation. The sepals beneath the flowers are unable to form a cylindrical calyx tube, which support based on petals. During bud opening the calyx may be split either half or completely. Reason is mainly - Genetic, High dose of Ammonium nitrate, Low dose of N₂, High day and low night temperature, High density planting and Low boron level.

5.5 Sleepiness: It is another disorder in carnation, it mainly occurs by high ethylene synthesis or water stress. Ethylene synthesis occurs much higher when flower are stored for long periods or when they are kept at high temperature.

5.6 Flower bud blasting: A disorder found in tulip that is cause by dry storage or forcing of bulbs. It has been reported a change in the plants hormonal status, which regulate the distribution in carbohydrates and other organic materials within the plant, is main reason of blasting.

5.7 Topple: Topple in gladiolus is characterized by breaking of spikes after opening of the florets in the vase. The spikes harvested from calcium-deficient soil have higher incident in topple.

5.8 Bull Head: Thrips infection, insufficient carbohydrate supply to developing buds and hard pruning cause bull head in rose. Affected roses have shorter shelf life.

5.9 Petal Discoloration: Low night and day temperatures are correlated with accumulation of pigments and is accompanied by blackening of petals and often stimulated by of ultraviolet radiation through the materials covering the greenhouse. Bluining duration storage is attributed to breakdown of proteins, release of free ammonia and concomitant increase in pH. Bluining of red rose petals is increased by the use of AOA but reduced by the use of STS.

5.10 Leaf Wilting: A lower rate of water uptake caused by bacterial plugging is prevalent in chrysanthemum. Placement of the stems in cold water overcomes the problem.

6. Post-harvest factor in ornamentals

6.1 Temperature: Optimum temperature is major factor longevity of flowers. Opening of flower buds and rate of

senescence accelerate at higher temperatures (Gupta and Dubey, 2018) [6]. At lower temperatures, the respiration rate come down and flower produce a lesser amount of ethylene and multiplication of micro-organism does not take place is faster rate. Tropical flower are very sensitive to low temperature and these flowers should be stored at high temperature (8-15) °C. Temperature plays an important role for flowers harvested at the immature stage which allows bud full expansion when it reaches ultimate consumers. In such case flower bud may be kept at temperature as low as 0°C in carnation, 1°C for rose, 4°C for gladiolus, and 10°C for tropical and sub-tropical orchids. Pre-cooling temperatures of different cut flowers should be maintained at the optimum to removed field heat.

6.2 Light: Cut flowers already treated with floral preservatives are not much affected by flower preservatives. Light is essential for long distance transport or prolong storage in Alstromeria, Chrysanthemum, Dahlia, Gladiolus flowers. Similarly, high light intensity is essential for opening of tight bud cut flowers. Flowers like carnation can be stored in darkness for a long period without affecting quality. Chrysanthemum should be illuminated during storage with a light intensity of (500-1000) klkto protect the plants from yellowing of leaves. Blackening of petals has been found to stimulate by penetration of UV radiation through covering materials of greenhouse. Potted plants generally transplanted long distance in darkness. Long period of darkness cause yellowing of newer terminal foliage, leaf and flower and excessive shoot elongation. Plants like Aglaonema, Brassia and Yucca can be kept in darkness for 30 days without any loss of quality or very little loss (Tijssens *et al.*, 1996) [13].

6.3 Humidity: Cut flower should be kept at 90-95% relative humidity for maintaining turgidity and prolong self life during post-harvest time (Doi *et al.*, 2000) [5]. Flowers start showing wilting symptoms when they have lost 10-15% fresh their weight. The rate of transpiration from leaves is reduced with increase the of high relative humidity. But it should be kept in mind that flowers are subjected to infection by fungal and bacterial disease at high temperature associated with high relative humidity. Cut flower and herbaceous cuttings containing a sufficient amount of water should not be stored in dry atmosphere because they become less turgid through quick penetrate. High temperature cause high transpiration.

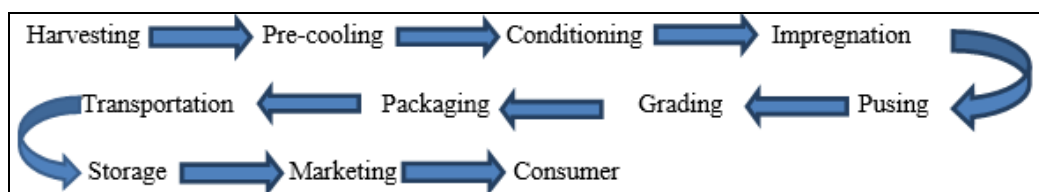
Relative humidity measure by hygrometer or hygrograph. During pre-cooling and shipment of cut flowers and herbaceous cutting, the relative humidity of air should be maintain 90-98%. Higher air humidity reduction water loss and petals wilting.

6.4 Water quality: Water quality is defined as pH and EC value, hardness contents of phytotoxic elements and micro-organisms causing vascular occlusions affecting longevity of cut flowers. The quality of water used in vases is an important factor influencing the longevity of cut flowers. The constituents of tap water which vary greatly in various locations affect the longevity of flowers as well as the efficiency of chemical solutions used in holding, pulsing and bud opening solutions. Saline water the decreases the vase life of flowers. Sensitivity of cut flowers to salinity varies among different species. For cut gladiolus, the longevity of flowers decreases when the concretion of salts in the water reach 700 ppm, whereas for cut roses, chrysanthemum, carnation 200ppm is harmful (Waters, 1968) [15]. The increases the concretion of salts over 200 ppm shortens vase life by half a day for each 100 g per liter increase the salinity.

6.5 Ethylene: It is a phytohormon, play an important role in the regulation and co-ordination of senescence in climacteric flowers. Production of hormone is less and stable in floral bud and young flower but highly ethylene secretion is found during flower maturation, opening, senescence. Afterwards ethylene production decreases and remains static. A wide range of flowers is affected by ethylene, with showing some typical symptoms such as- (a) Sleepiness of carnation. (b) Fading or rolling of corolla of ipomoea. (c) Fading and wilting of sepals tips in orchids. (d) Induction of anthocyanin formation in female reproductive parts. (e) Abscission of flowers and petals. So, some criteria should be maintain for prevent ethylene synthesis such as; -Low concentration of oxygen or hypobaric or keeping the flowers at low temperature.

7. Post-harvest handling:

It is a process or management practices for improvement of quality after harvesting of crops. Different crops such; fruit crops, vegetable crops, plantation crops and flower crops have specific management practices but, here we are discussing only flower crops.



Post-harvest handling Chain

7.1 Harvesting: Harvesting is a process of gathering a ripe crop from field.

7.2 Pre-cooling:- It done for removes field heat. After harvest placing in cold room or open box for remove by excess heat. It also done by forced, cooling, hydro-cooling, ice bar cooling etc. If decrease optimum temperature by pre-cooling so that Botrytis infection may be start and reduction of ethylene from the package.

Advantage- prevents water loss, decrease flower sensitive to ethylene, Reduction respiration rate.

Example- Alstroemia 4 °C, Anthurium 13 °C, Rose 1-3 °C, Gladiolus 4 °C.

7.3 Conditioning: Conditioning or hardening is a simple process where flower are kept standing loosely in a big container so that air can circulate around the stems. The purpose of this treatment is to restore the turgidity of cut flowers from water stress during storage and transportation.

Conditioning is achieved by treating the flowers demineralized water supplemented with germicides and acidified with citric acid to pH 4-5.

7.4 Impregnation: Sometime end of the cut portion treated some chemical for short time. That result, protects the blockage of water vessel in the stem of microbial growth and stem decay. Impregnation of cut bases of rose flower with high concentration of silver nitrate (AgNO_3) or Nickel chloride (NiCl_2) for 10 minutes (Knee, 2000) [9].

Example: Aster, Gladiolus, Gerbera, Dahlia.

7.5 Pulsing: The absorption of chemical solutions containing sugar and germicide through the lower cut baseds of flower stems is known pulsing. Pulsing is mainly done for increase vase-life, Promoting opening, improve the colour and size of ornamentals. Pulsing is employed with high concentrations of sugar, mainly sucrose, the percentage is very crop to crop and species to species.

- Example: Chrysanthemum it should be needed 2-6% sucrose (Bhattacharjee and de 1998) [1].
- Birth of Paradise or Carnation needed 10% sucrose (Crilley and Pul 1993).
- Gladiolus needed 20% sucrose (De *et al.*, 1996).

7.6 Grading: Grading is means the grouping of flowers based on quality prior to marketing. Each bunch made up to the same size, weight or quality of blooms to fetch in good market. Grading is done basis parameter like appearance, stage of maturity, blemishes or injury due to disease. Good quality grading character are stem should be straight, proper length, leaves should be dark green and bright, free from disease or residue of any chemical spray. According to international grade of rose flower should be uniform in colour, stem length and development are grouped together and universal four grades always maintain for gladiolus flower such as; uniform in colour, stem length and development are grouped together (Staby *et al.*, 1978) [12].

7.7 Packaging: Packaging should prevent flowers from physical damage, water loss and external factor during transport. Type, Size, and capacity of packaging varies from flower to flower, nature and distance of market. Flower are generally grouped into 5,10,12,15 or 20 stem and loosely tied with rubber bands. Before placing in the package, individual flower bunches are wrapped with suitable packing materials like cellophane, Kraft paper, newspaper, tissue paper or corrugated card board sheet. But local market the bunch is held in buckets container.

7.8 Transportation: Flowers are short lived and perishable in nature and should be delivery destination as early as possible immediately harvest. There are three methods of transportation for ornamental plants to be shipped by truck, air and sea but air transport is the costliest of the three methods but it is fastest. Track transportation is the main mode for foliage plant or cut flower, must be provided like cooling system, heating system, artificial light facility and also maintained relative humidity. Certain plants like; *Dracaena*, *Areca*, *Polyscia*, *Brassia* respond well in sea. But Desiccation is the major problem in sea transportation and overcome these problem the following step are recommended. Growing media should be modified, plant protects from

drought condition, relative humidity, temperature and artificial light should be maintained.

7.9 Storage: It is very important and last stages post-harvest method of foliage and other ornamental plants. Storage mean, mass amount of ornamental are kept under cold house for few days or months.

1. Optimum levels of light, temperature, relative humidity, ethylene and soil moisture should be maintained in the storage environment.
2. In the storage condition low metabolism in tissue, slow down respiration and transpiration rate, ethylene production and retards the multiplication of bacteria and fungi growth (Mahajan *et al.*, 2014) [10].
3. Some foliage plants can be show some dis-advantage, if store long days under cool storage. That problem are- leaf chlorosis, flower and foliage drop, desiccation or reduction of plant grade.
4. Storage are different type such as cool storage, wet storage, dry storage etc.
5. Gladiolus flower can be store polypropylene packing under cold storage for 10 days (Singh, 2007) and Dastagiri *et al.*, (2014) [3] reported that *Ornithogalum* spikes can be best stored up to 3 days at 4°C in modified atmosphere packaging with cellophane.
6. Ex- Bulbous plants needs 4-5 °C, Rose and carnation needs 0-1 °C.

7.10 Market: Market mean, a region or a place where consumer come here and buying their preferable or choice able product. India has different market in different part of city. Some important market is Mumbai, Kolkata, Delhi, Chennai, Hyderabad and Bangalore.

Marketing Channels: -There are three marketing channels followed by flower growers.

1. Producer---Wholesaler ---Retailer---Consumer.
2. Producer---Pre-harvest contractor---Consumer.
3. Producer---Processor.

8. Agri-Export zone

The concept of Agri-Export zone takes a comprehensive look at a particular produce/product located in a contiguous area for the purpose of developing and sourcing the raw materials, their processing/ packaging, leading to final exports. The main focus boosting agricultural exports from India (Export between different state or export between different country) in March 2001, Government of India declared a policy of setting up of Agri Export Zones across the country. The Central Government has sanctioned 60 AEZs comprising about 40 agricultural commodities. AEZs is spread across 20 states in the country.

The agri export zone in India (Floriculture):-

1. W.B(Darjeeling and Kolkata)
2. Karnataka (Bangalore, Dharmapuri, Nilgiri)
3. Uttarakhand (Dehradun, Pantnagar, Nainital, Udham Singh Nagar and Uttarkashi)
4. Maharashtra (Pune, Nasik)
5. Sikim (East Sikim).

9. Scope of post-harvest industry in India

India is an Agriculture country where, more than 80% people directly depend upon Agriculture. That mean, Agriculture is the back born of Indian economics and other side post-harvest industry has tremendous potential power to increase Indian economics. The main objective of post-harvest industry are store of the harvest crops (Fruit, Vegetable, Flowers,

Plantation and Medicinal plants) store long time without physical, biological and chemical change. Because, in these Horticulture crops highly perishable in nature. Some important scope is mention below.

1. India is a biodiversity countries where, different types of Flowers can be grow throughout the year. So, all over the year flower flowers can be store.
2. Europe is a neighborhood country in Indian. Where, weather condition is not so good, that mean cool and frost weather dominant throughout the year. So, commercially flowers cultivation is not possible. That is very good scope for India to export of the flowers and earn money.
3. Various type of government support also found so that, so many person also interest to involve this type of business.
4. Land is available in India that is the first and vital criteria before buildup industry. It is an import scope to buildup industry.
5. Labor is available in India and rate is also cheap. So, it is another good scope to buildup industry.
6. Some flowers (Rose, Gladiolus, Carnation, Gerbera, Tuberose, Orchid) has good demand in a specific time (Mother's day, Valentine Day, Christ mass day, New year's and Teachers day) but, these flowers only available in a specific time. If, in these flowers store long time and supply off season so, farmers can get more profit.
7. Post-harvest industry not only store flowers crop but, it also store fruit and vegetable and different types value added product such as; jam, jelly, pickle, fruit juice, dry vegetable product also. That mean throughout the year healthy food supply.

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