

Pre-Harvest Management for Total Quality Improvement in Fruit

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Introduction

India is endowed with different agro-climatic condition that offers immense scope for cultivation of various kinds of fruit crops. Fruits are the prime source of vitamins and minerals without which human body cannot maintain proper health and resistance to the diseases. Indian Council of Medical Research (ICMR) has recommended the consumption of at least 92 grams of fruits per day and as much variety as the season permits (Anonymous, 2001a). On the contrary, the per capita consumption of fruits in India is only 46 grams per day. This indicates the wide gap between the use and requirement of fruits. Hence it is necessary to increase the productivity of fruit crops. The major fruit crops grown in India are mango, banana, citrus, grapes, guava, papaya, sapota, pomegranate, jack, ber, aonla etc. it is widely recognized that variations in mineral content greatly affects fruit quality at harvest and changes after harvest.

The present day requirement is for further enhancing the trade by offering quality fruits with appropriate application of pre-harvest treatments. Quality fruits have more demand and also fetch more price in the market. It helps in increasing the foreign exchange and also the economic condition of farmers.

❑ What do you mean by quality?

- Quality means a combination of characteristics, attributes and properties that gives the values to human and enjoyments.

- Consumers consider good quality in relation to colour, flavour and nutrition.
- The ultimate quality is the final manifestation of inter relation between the commodity and its environment.

❑ Pre harvest factor affecting quality of fruit

- 1.Environmental aspects
- 2.Cultural aspects

1. Environmental factor:

Following are the environmental factors affecting quality of fruits –

➤ Temperature

It is an important determinant of plant growth. High as well as low temperatures influence growth of plants. Broad leaved, evergreen plants are more susceptible to low temperature.

High temperature reduces the quality in citrus like maturity, colour, sugar acidity etc. and increased the quality in grape and melons. Low temperature caused the chilling and freezing injury. Development of red colour in blood orange is governed by low temperature. More severe winter favours discontinuous synthesis of chlorophyll and unmasking of carotenoids pigment which imparts red colour to oranges.

Carbohydrate synthesized by plants may be stored as starch , sugar etc. or converted to proteins, fats, organic acids etc. Sweetness determines the quality of many fruits and low temperature helps in accumulation of sugars while high temperature causes its degradation. Temperature at the time of collection of horticultural products greatly influences the quality through adjustment of sweetness lower mean temperature during the period of maturity and harvesting

retard the rate of respiration and also the conversion of sugar to starch.

➤ **Light:**

Light is the important factor which influence the organism, more so the autotrophic plants. Tee light is found to affects the quality of the fruits. Fruits exposed to light are found to be better in quality as compared to fruits receiving less light. In mandarin, it has been observed that, the fruits borne on upper halt of the tree and consequently receiving more light were found to be richer in vit. C content.

It also essential for anthocynin formation. Exposed fruits to sun light develop lighter weight, thinner peel, lower juice and higher TSS than shaded fruits like citrus, mango etc. High sun light causes sun scald in citrus.

➤ **Rainfall:**

Water is the major constituent of protoplasm. Rainfall is the ultimate source of most of the water supply of all life and especially so to plant. Plants have some critical period of water requirements and adequate supply of water during these stages defiantly raises the quality and yield.

Rain at the time of flowering washout the pollen grains and greatly reduced the fruit set and quality of fruits. High rainfall causes cracking the grapes, lemons, dates, litchi etc. it also reduces appearance and sweetness.

➤ **Wind:**

Heavy wind velocity is detrimental to the plants. It causes damage to fruits tree in several ways high wind blow away the fruit and break the branches. Hot wind at the time of blossoming may cause failure of pollination due to drying of stigmatic fluid and reduced the activity of pollinating insect.

It may cause abrasion of fruits. Mild wind velocity produce wind scaring disorder in citrus when the fruits is rubbed against twigs or thorns. Thorns punctures may heal over with corky scar tissue and brushing on the fruit of citrus.

➤ **Relative Humidity :**

It is crucial component of climate influencing growth and production of crop. Humidity is essential for growth of the plants and qualitative development of the fruits.

The colour, TSS sugar acid blend are better in dry atmosphere having very little humidity. The oranges grows under high humidity have thin rind and have more juice. Low humidity favours better colour development in oranges.

High humidity increases the acidity in citrus and grapes etc. but on other hand it is needed for better quality of banana, litchi and pineapple.

➤ **Soil:**

Soil is an important for establishing an orchard and maintain the quality of fruit. In general it may be stated that soil for fruits growing should be porous, deep and well aerated should not be water logged, marshy, saline or acidic and there should be no hard pan at the bottom layers.

Fruits ripen a little earlier on tree growing in sandy or gravelly soil than clayey soil in a poor drained soil, the soil interspaces are water-filled and aeration is thus reduce.

2. Cultural aspect:

Below mentioned factors affecting quality of fruits –

➤ **Foliar spray**

The foliar spraying of organic compounds other than nutrients which in small quantity modify the plant physiological process which ultimately improves the quality. Growth regulators used to improve the quality and foliar spray of fungicide reduces the incidence of disease by pre harvest applications.

In foliar application ethylene inhibitor plays an important role in maintaining the quality of fruits. The ripening of fleshy fruits represents the unique coordination of developmental and biochemical pathways leading to changes in color, texture, aroma, and nutritional quality of mature seed-bearing plant organs. Recent developments in the regulation of fruit ripening with an emphasis on the regulation of ethylene synthesis, perception, and response.

Fruits have classically been categorized based upon their abilities to undergo a program of enhanced ethylene production and an associated increase in respiration rate at the onset of ripening. Fruits that undergo this transition are referred to as climacteric and include tomato, apple, peach, and banana whereas fruits that do not produce elevated levels of ethylene are known as non climacteric and include citrus, grape, and strawberry.

➤ **Fertilizer application-**

Nutrition of the plant is by far most extensively studied of the factors affecting the quality of harvested produce. It has been observed that size, weight and ascorbic acid and decrease by high N and P. Fertilization with major elements, such as N,P,K and Ca affect the internal quality of fruits. It will be noted that titratable acidity was increased by application of K. TSS was increased by N and decreased by K nutrition.

It indicates excessive fertilizer application decrease fruit firmness and increased the solubility of cell wall constituent. P provides for fast and vigorous growth and speeds maturity. P stimulates flowering and seed development necessary for the enzyme action of many plant processes. K used to form

carbohydrates and proteins, formation and transfer of starches, sugars and oils and it increases disease resistance, vigor and hardness.

➤ **Irrigation management-**

Irrigation is very important in fruit crops as sufficient moisture must be maintained in the soil for obtaining the yield of good quality fruits. The irrigation system have to be properly devised so that the water requirement of the trees are met at the minimum expenditure without any wastage of water.

System of irrigation of fruit plants vary with the age of trees. Several methods are employed for the irrigation of fruit trees depending on the age of the tree, soil topography and the availability of irrigation water.

➤ **Bagging –**

Bagging is technique which can increase the colour uniformity and can induce earliness in the ripening process of fruits. Uniform colour of the whole fruit is reached because the fruit protected against the direct incidence of the sunlight and also induce earliness in the ripening process by providing favorable microclimate to the fruits.

Advantages and limitation of pre harvesting of bagging

- **Advantages-**

1. Pre-harvest bagging of fruits protects from infestation of fruit fly and attack by sooty mould disease.
2. It protects fruits from damage by bruises arising due to strong winds and birds attack.
3. It ensures uniform fruits ripening with attractive colouration and higher market appeal.
4. It also protects fruits from damage by post-harvest diseases.

- **Limitation-**

1. Bagging cannot improve the colour of some coloured varieties of fruits

crop. Eg. In Vanraj Variety of Mango.

2. When using plastic bags, open the bottom or cut a few small holes to allow moisture to dry up. Moisture trapped in the plastic bags damage and/or promotes fungal and bacterial growth that caused diseased-fruits. Plastic also overheats the fruit.
3. Bags made of dried plant leaves are good alternatives to plastic.
4. Remove the bags during harvest and disposed them properly.

➤ **Maturity indices -**

These are the measurable points which give notation of harvesting which ensures proper quality of produce. Some commonly used maturity indices are :-

- | | |
|-----------------------|---|
| 1. Calendar date | - All fruits |
| 2. DFFB | - All fruits and radish |
| 3. T-Stage | - Apple |
| 4. Size | - All fruits, cherry |
| 5. Surface morphology | - Grape (cuticle formation), banana, litchi |
| 6. Specific gravity | - Cherries, Mango and Ber. |
| 7. Color | - All fruits, Muskmelon |
| 8. TSS | - All fruits, and melons |
| 9. Firmness | - Pome and stone fruits |
| 10. Juice content | - Citrus |
| 11. Acidity and Sugar | - Pomegranate, Citrus, Papaya. |
| 12.TSS/ acid ratio | - Grape and Citrus |

The maturity index for a commodity is a measurement or measurements that can be used to determine whether a particular commodity is mature.

• **Importance of maturity indices-**

1. Ensure sensory qualities.
2. Ensure adequate post-harvest shelf-life.
3. Facilitate scheduling at harvest and packaging operation.

4. Facilitate marketing over the phone or through internet.

➤ **Harvesting methods-**

Harvesting is a deliberate operation to separate the produce from source of its attachment. This is very important operation as far as quality, shelf life, transportation; marketing, processing, value addition and ultimately consumer satisfaction are concerned.

- **Types of Harvesting –**

- 1. Manual harvesting-**

In India, mostly manual harvesting is adopted human labour is deployed to harvest the produce. Secateurs, sickle, clipper etc. are made use to harvest depending upon nature, kind and extent of farming. Hand harvesting is followed for most of the fruits.

- 2. Mechanical harvesting-**

It is used in case of apple, strawberry, cherry, raspberry etc. The harvesting is achieved by shaking the tree by mechanical vibration. The tree is shaken by mechanical vibration and the fallen fruits under tree are collected over a large blanket or in net. The harvested fruit receives injury.

- 3. Chemical harvesting-**

Some chemicals are sprayed on the tree before harvesting to loosen the attachment of the fruit to the plant. Following shaking the fruits fall down from tree. Spray of 2 4- D @ 500 ppm and 200 ppm. Resulted in keeping the buttons of kinnow and eureka lemons fruits respectively, intact and green during storage. MH @ 1000 ppm delayed the ripening of hard green mangoes during storage.

- **Importance of Harvesting-**

1. Harvest only mature fruits.
2. Pick fruit early in the morning or late in the evening.
3. Harvest fruits with 1.0 cm stalk or above the first node of the stalk. It prevents sap oozing.
4. Harvest fruits with hand or harvester developed by the Institute.
5. Do not harvest fruits with stick or shaking the tree/branch.
6. Keep harvested fruits in plastic crates or on tarpoline / cloth / newspaper under shade. Avoid contact of fruits with soil.
7. Avoid latex flow on fruits during harvesting and handling.
8. Desap the fruits, particularly for export, by inverting them in a desapper for about 25 – 30 minutes.

- Crop wise Cultural aspects -

1) Mango

Fertilizer application

- Among many plant mineral nutrients K play important role to improve the fruit quality.
- Soil applied K fertilizer compare to foliar application resulted in improved fruit quality attributes.
- There is a high demand for K during fruit development.

Water management

- Bearing mango trees are not generally irrigated.
- However watering at an interval of 10-15 days during fruit setting and fruit development is advantageous to reduce fruit drop to increase fruit retention, size and fruit quality.

Foliar spray

- GA₃ 150 ppm

- i. Improves fruit size and fruit weight.
 - ii. Fruit volume improves
 - iii. Produced maximum T.S.S.
 - iv. Increases in ascorbic acid and acidity decreases.
- 2, 4-D 10 ppm
 - i. Increase size of fruit
 - ii. Increases T.S.S. and ascorbic acid
 - 2, 4, 5-T 100 ppm
 - i. Increases total sugars
 - ii. Increases the ascorbic acid
 - iii. Reduced the acidity

Bagging

Efficiency of different bagging materials for the control of the mango fruit fly and black spots % occur during Mango season. The experiment is carried out at Kallyanpur by Sarker *et al.* (2009). Fruit bagged at 30-40 days before crop harvest.

T1=Polybag (black), T2=Polybag (transparent)

T3=Brown paper bag, T4=Control (no bagging)

They found that all three bagging materials gave full protection against the fruit fly infestation and of all evaluated brown paper bag showed maximum reduction in the black spots (4.3to 5.5%) in mango fruits in cv. Langra and Khirshapat, however black spot were higher in polybag.

Maturity indices

- Fullness of shoulders
- Internal and external color
- Starch content; specific gravity

Harvesting methods

- Mangoes generally harvested by Nutanzela in India and in foreign countries mechanical harvester is use.

2) Banana

Foliar spray

- One foliar application of Agromin 4 gm + Urea10gm +MOP 10 gm per lit. water 3 weeks after flowering, give good harvest of attractive fruits.
- Spraying K₂SO₄ 3% at 3rd and 4th week after bunch emergence increase the bunch weight, finger character and shelf life in banana.
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Fertilizer application

- A nutrient loving plant requires large quantity of nutrients for its growth and developments.
- Potassium is much wanted element for banana and its requirement is high during flowering period.
- Its stimulate early shooting, increase number of hands, finger size, improve quality and sweetness.

Water management

- It is a moisture loving plant.
- It requires adequate soil moisture throughout its life.
- Irrigation requires during early vegetative period, flowering, fruit development up to ripening.

Maturity indices

- The edges of fingers become round.
- Change in color of fruits and TSS

Bagging

The experiment was carried out by Debnath *et al.* (2001) with title Effect of bunch cover on size, weight of finger and other finger characters in cv. Giant Governor. *Bunch covered with bags after the opening of last female bract. They observed that the highest finger length (16.03 cm), diameter (3.85 cm), weight of finger (114.0 g), weight of pulp (79.75 g) and peel (34.25 g) with transparent polythene cover and they also recorded that highest pulp content (70.36%), pulp: peel ratio (2.37:1) and lowest peel (29.31%) with blue polythene cover in banana bunch cv. Giant Governor.

3) Grapes

Fertilizer application

- Phosphorous is necessary at flower bud initiation stage nitrogen is mainly required at fruit ripening stage.
- Potash is required during fruit set and fruit development.
- 50 % N and P fertilizer were applied after fruit set to veraison
- 25 % K supply between verasion and before harvest increase the cluster size, no. of fruits per cluster, increase berry size and also increase TSS, sugar and yield.

Water management

- Irrigation at an interval of 5-7 days during initial development stage till they become pea size.
- 10 days interval till maturity is better for good yield watering should be withheld 25-30 days prior to harvesting to insure quality of produce.

Foliar spray

- GA3 75 ppm

- i. Increases in the bunch and berry size Increases yield
- ii. To give maximum recovery and produce fairly good quality raisin.
- Ethephon 500 ppm
 - i. Increase TSS,
 - ii. Reducing sugars, non reducing sugars and total sugars.
 - iii. Decrease acidity
- Chiston 1g/ lit.
 - i. Decrease incidence of disease.
 - ii. Inhibit spore germination and mycelia growth of phytopathogen.

Bagging

Signes *et al.* (2007) Effect of bagging on grape bunch and volatile aroma composition in cv. Perla and reported bagged cv. Perla grape increase volatile aroma composition of limonene (9.6%), Trans-2- Hexenal (2.2%), 3-Hexenal (2.4%), 2-Hexen-1-ol (59.4 %) while Ethyl acetate (66.2%) was found maximum in non-bagged grapes.

4) Citrus

Fertilizer application

- Half dose of N + full dose of FYM, P and K be given at the time of release of water stress.
- Remaining half dose of N be given when fruit attain the pea size.

Foliar spray

- GA3 75 ppm
 - i. Increase fruit size improve fruit quality.
 - ii. Reduction in seed per cent

- 2, 4-D 10 ppm
 - i. Fruit weight increases.
 - ii. Produce maximum number of fruits.
 - iii. Fruit yield increases
- CaCl₂ 4-6%
 - i. Increase Vit. C content.
 - ii. Increase juice per cent

Water management

- It is essential at the time of flowering and fruiting period.
- Mostly required at maturity period of fruits

Maturity indices

- Size of fruit.
- External color
- Juice content

Harvesting Method

- Plucking with hand or use of knife for cutting with some twig portion.

5) Guava

Foliar spray

- GA₃ 200 ppm
 - i. Increase fruit size.
 - ii. Improves fruit weight
 - iii. T.S.S. increases
- CaNO₃ 0.5-1.5%
 - i. Minimize PLW

- ii. Increase palatability rate
- iii. Increase TSS, Ascorbic Acid
- Ethephon 600 ppm
 - i. Produce better quality fruits
 - ii. Produce higher ascorbic content
 - iii. Better ripening
 - iv. Retained higher content of T.S.S.
 - v. Acidity decreases

Water management

- In bearing trees irrigation is beneficial to increase fruit size, fruit set and quality
- Adult bearing tree requires watering during April to June at fortnightly interval to insure high fruit set and fruit drop.

Bagging

Montoya *et al.* (2010) reported that the percentage of oviposited fruits were higher in control (92.50%), while it was minimum under Tergal bag (0.52%) in Taiwanese guava cv. Tai-Kuo.

Maturity indices

- Size of fruit
- Color of skin
- TSS

Harvesting Method

- Plucking with hand or use of knife for cutting with some twing portion.

6) Pomegranate

Fertilizer application

- Addition of NPK fertilizer with the chelate iron cause significant in fruit weight juice per cent, thickness and weight of epicarp and decrease fruit cracking percentage.

Foliar spray

- GA3 at 200 mg per lit.
 - i. Significant increase in total yield weight.
 - ii. Increase juice per cent.
 - iii. Increase TSS.
- Fe at 200 mg per lit.
 - i. Increase in TSS total acidity reducing sugar
 - ii. Increases anthocynin pigment percent.

Water management

- Ordinary irrigation practices are quite enough.

Maturity indices

- Skin colour change to yellowish red.
- Fruit gives a metallic sound when tapped.
- Closing of calyx at distal end of fruits.

Harvesting Method

- Plucking with hand or use of knife for cutting with some twigs portion.

❑ Conclusion

- Pre-harvest spray of PGR and other chemicals plays important role in improving quality of fruit and help in enhancing shelf life of fruit crop.
- One of the best way to meet the increasing demand of quality fruits

and reduce the wide gap between demand and supply.

- It helps in increasing the foreign exchange and also the economic condition of farmers.
- Maturity indices and proper harvesting method are plays an important role in quality improvement.
- Bagging is an efficient technique regarding induced uniform maturity followed by ripening with full attractive colour and aroma development.
- Bagging improved quality in terms of chemical characteristics like, TSS, Reducing sugar (%), Non-Reducing Sugar (%), Total sugar (%) along with helpful to reduced pest incidence.

References (if any)
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