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REVIEW ARTICLE

EFFECT OF PRE-HARVEST FACTORS ON POSTHARVEST QUALITY OF HORTICULTURAL PRODUCTS

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ABSTRACT

Postharvest quality of the products refers to the market quality, table quality, appearance quality, nutritional quality and many more. All the quality such as size, shape, texture, taste, free from insect pest and diseases are the key pre-harvest factors affecting the postharvest quality .Pre-harvest factors also have great effects on growth and development of plants. Quality of fresh horticultural produce are the combination of characteristics, attributes, and properties that give the value for food and enjoyment to consumers. Pre-harvest factors consists of genetic, environmental, cultural and physiological components. The genetic characteristics and physiological status of the commodity help to determine the typical postharvest behavior and quality of the produce. Various farmers, scientists, specialists of these field should work together in order awareness, knowledge to ensure to optimized the pre-harvest factors for higher production of quality horticultural products. The main aim of these review is to learn about the pre-harvest factors that affect the postharvest quality of products. It was also concluded that by these study we can clearly understand these pre-harvest factors in order to maintain the postharvest quality of product.

KEYWORDS

Postharvest Quality, Pre-Harvest Factors, Horticultural Products, Genetic, Environmental, Characteristics.

1. INTRODUCTION

Over the past 40 years observations, it was found that about 40-50% of the horticultural crops from the developing country are lost mainly because of climatic change, water loss, bruising, breakage etc before they are consumed (Kitinoja, 2002). In Nepal, various studies have shown that the postharvest loss of fruits and vegetables are found to be 20-30% (Bhattarai, 2017). The quality of commodity are governed by many factors. The combined effects of all these factors decides the rate of spoilage and deterioration of the products (Ahmad, 2015). If they are not controlled timely may lead to large scale of the postharvest loss and degrade its quality. To obtain the maximum postharvest quality of the products begins from the early farm planning process. The effects of pre-harvest factors on postharvest quality of products are often overlooked and underestimated. However, many decisions that we make during the production and cultivation of crops greatly effects its postharvest quality.

Loss of both quality and quantity affects the horticultural crops from harvest till consumption. About one third of fresh fruits and vegetables are lost before it reaches to the consumers (Kader, 2002). Thus, this review is mainly focuses on the causes of qualitative and quantitative loss of the horticultural crops with the effective measures to control loss in our Nepalese context.

It emphasized on adoption and the practices of the innovative technologies in order to improve the quality and freshness of the commodity. Reduction of postharvest loss and quality deterioration are very much important for increasing food security, its availability from the existing production.

2. DISCUSSION

Postharvest management of crops starts with pre-harvest management practices. Once the fruits are harvested, the overall quality of products can't be improved but it can be maintained properly. The final market value of the products and its acceptance by consumers solely depend on the suitable pre-harvest technology followed by harvesting and then postharvest handling practices. Those pre-harvest factors that affect the postharvest quality are cultural practices like frequency of irrigation, use of fertilizers, growth regulators, climatic conditions like very hot and cold weather, natural climates like hailing, erratic rainfall, and plant condition like age, light penetration, training and pruning practices. These all factors influence the fruit quality, chemical composition, morphology, physiology and suitability for storage for long term.

The description of the pre-harvest factors that effects the postharvest quality of products are discussed below:

2.1 Genetic Factors

The cultivar of horticultural crops is one of the most important factors in determining variation (Crisosto CH, 1997). The growers should have choice for selecting suitable cultivars before planting the crops however it may be limited with the availability of the planting materials. And the eating habit and need of the consumers should be keep in mind of the growers. Similarly plant breeding has been done in wide range of commercial fruits and vegetables varieties consisting different quality attributes made available to growers for cultivation. The selection of right variety of vegetables along with suitable marketing channel greatly influence the postharvest quality of vegetables (Prussia, 1993).

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Those cultivars that have great ability to withstand rigor of marketing and distribution may have lesser postharvest loss after harvest but however, in some cases they tend to lack sufficient sensory quality. The varieties having short shelf-lives are more prone to postharvest loss while the varieties with low respiration rate, low ethylene production have comparatively longer storage life.

Nowadays, horticultural breeding and biotechnology plays significant role in maintaining and improving the postharvest quality and safety of fresh produce (Bekele, 2018). The potential of improving both the productivity and quality of horticultural crops is very essential. However, increased in planting or the production will not occurs until the market is ready for accepting and promoting these products that provides compelling benefits for all growers, marketers and consumers (Hall, 2004).

Therefore, major focused should be made on attaining and maintaining good flavor and nutritional quality and introduction of varieties that are resistance to low temperature disorder or resistance to decay-causing pathogen to be stored for long duration with minimum loss. So, the growers must select those varieties that inherently have good quality, disease pest resistance and storage potential along with higher productivity.

2.2 Maturity at Harvest

Maturity refers to that stage in which the commodity reaches to sufficient stage of development so that after harvesting and handling its quality will be at least minimum that is acceptable to the consumer". Maturity at harvest is the most important factor that influence the postharvest life and final quality of horticultural crops. Mostly, grower faces difficulty in deciding when to harvest. So .they must be harvested when attained appropriate stage of development based on physiological and horticultural maturity (Bekele, 2018).

Physiological maturity is that stage of development when plant obtained maximum growth and maturation. It allows normal ripening even after harvest. Similarly, (Kader A. , 1984) states that "Horticultural maturity refers to that stage of development in which plant or its parts are ready to be use by consumers for particular purpose". The use may occurs at any development stage depending on the crops.

Fruits and vegetables which are harvested at immature stage are susceptible to shriveling and mechanical damage whereas those fruits and vegetables harvested at overripe stage have poor texture, flavor and short shelf live. Fruits and vegetables that are harvest too early or too late in season are more susceptible to physiological disorder and have shorter storage-life that those harvested at proper maturity. Therefore, harvesting at optimum maturity stage is very important determinant for longer storage-life and final quality of products.

Various quality characteristics such as shapes, sizes, color, texture, dry matter, productivity levels, taste attributes are greatly influenced by the stage of maturity at harvest. There are various method for determination of maturity such as Physical method (Size, shape, color etc), Chemical methods (TSS, acidity, etc), Physiological methods (Respiration and ethylene production), and many more. According to (Palou, 2001), if the dry matter content is less than 14.5% at harvest then, it is unlikely that fruit soluble solid content at the time of eating will exceed 12.5% which is the minimum threshold for consumer acceptance.

2.3 Climatic Factors

Various Climatic factors such as temperature, light, Relative humidity, wind, CO_2 and rainfall have direct or indirect influence in plant growth and development. These climatic factors may result in direct loss of fruits and vegetables from postharvest chain due to increased incidence of pathogens, heavy rainfall during harvesting and loss due to freeze damage. The management of temperature, ventilation and relative humidity are major factors that affects postharvest quality and storage life of horticultural crops. Similarly, abiotic conditions like soil fertility and water availability also affect the quality of crops after harvest.

2.3.1 Light

Light is an essential factor in maintaining plant growth and development. It is essential for regulating various physiological process like photosynthesis, phototropism, respiration, stomatal opening and other metabolic process. The duration, intensity and quality of light effect the plant growth. The radiation of 400-700 nanometer wavelength are considered photosynthetically active radiation which support the process of photosynthesis. Mostly the horticultural crops required high light intensity about 3000-8000 F.C. (Woolf, 1999) performed the study with avocado produced with exposed sunlight on tree vs. under shade shown that the fruits that are produced with the exposure to sun consist of higher dry matter, high level of calcium, magnesium and higher oil content as compared to those shady fruits.

Table 1: Fruit Attributes of Sun Fruit (Exposed to The Sunlight on The Tree) and Shade Fruit (Inside The Canopy) in Avocado:

Attributes Measured	Sun Exposed Fruit	Shade Fruit
Dry Weight (%)	49.2	40.8
Total Oils (%)	29.2	24.0
Ca (mg/100 g/ F wt.)	30.9	14.9
Mg (mg/100 g/ F wt.)	94.0	61.0

Source: (Woolf, 1999)

Light intensity and quality both influence the postharvest eating quality of horticultural crops (Kays, 1999). Light intensity greatly influence the manufacture of plant food, leaf color, flowering and the length of stem. Similarly, light duration also plays critical role in plant growth. Horticultural crops are classified as short- duration, long- duration and day- neutral plants. Therefore, appropriate light intensity, quality, and duration are equally essential for optimum plant productivity and harvest index. (Hewett, 2006) explained that in perennial crops, utilization of light is very important determinant for productivity and quality as leaf area which are exposed to sun during daytime must be adequate to provide carbon needed for fruit and vegetables growth.

2.3.2 Temperature

All kind of physiological and biochemical process related to growth and yield of the plant are influenced by the temperature. It is considered as most important climatic factors which limit the shelf life of fresh fruits. Higher temperature during field condition greatly decrease quality and life of the products. (Irtwange, 2006) said that at high temperature, stored carbohydrates of horticultural crops are depleted at faster rate during respiration . Thus, those product having high amount of stored carbohydrates have longer storage life.

Similarly, temperature at the time of growth and maturation also influence fruit quality either by hastening or delaying horticultural maturity. For example, high temperature during fruiting season of tomato may leads to faster ripening of fruits on and off the plant. Increase in temperature directly affects photosynthesis which cause alterations in organic acids, sugar, and flavonoids content, firmness, antioxidant activity. Excessive high or low temperature both are considered harmful as it may lead to plant stress, inhibit plant growth, cause fruit drop, disease pest infestation and other physiological disorder reducing the postharvest life. Horticultural crops are mostly sensitive to temperature, therefore specific temperature requirement is essential for optimum development of yield and quality parameters.

2.3.3 Rainfall and Water Availability

Rainfall is also another important factor that cause postharvest loss of horticultural crops. Prolonged rainfall during the time of harvesting lead to the susceptibility to mechanical damage and decay during subsequent harvesting and handling operations.

Heavy rainfall and its consequences on crops leads to decrease in quality along with increase in incidence of physiological disorder such as skin cracking in apples and cherry (Sekse, 1995).

In general, <5% of water are absorbed by plant system which are utilized for growth and development of different plant components. Horticultural products are perishable with active metabolism which lead to great loss through microbial decay, physical injury, and senescence during postharvest life. Moisture stress at higher level affects quality and yield of the commodities by decreasing cell enlargement. These stress also increase rate of respiration over the rate of absorption. On the other hand, excess water also affect plants by increasing turgidity leading higher susceptibility to physical damage, reduce firmness and soluble solids contents and also delay maturity. Postharvest change in horticultural crops cannot be stopped, but can be slowed to certain limits. Generally, growers has been adopting water management strategy in order to minimize water stress for optimum photosynthesis, growth and harvestable yield. In some conditions, wise use of water supply decrease water usage and improve crop quality with sustainable growth. Nowadays, the Regulated Deficit Irrigation (RDI) system has been used successfully for wide range of crops which help to minimize water requirement without affecting plant growth and performance (Mills, 1997).

2.4 Mineral Nutrition

Effect of soil on plant performance and quality largely depends on a balanced and timely availability of mineral nutrients (Calouro, Jordao , Duarte , 2008). Inorganic mineral nutrients influence quality of horticultural products through various ways but mostly in physiological disorder (Ferguson, 2002). Plant nutrition is very important factor which affects both quality and postharvest life of horticultural crops. Balanced amount of essential nutrition is very important for growth and development of plants. Excess or deficiency of nutrition also affect quality and postharvest life to greater extent. Nitrogen and potassium are considered very essential nutrition required for plants (Cuquel, et.al, 2011). Numerous physiological disorder are related with mineral deficiency which consequently lead to postharvest loss. Various management practices have been developed for appropriate application of minerals and fertilizers to crops for better yield and quality. Fertilizers can be applied in soil or through foliar application or even by irrigation system in field.

Some of the specific postharvest disorder of horticultural product result from nutritional imbalance of certain mineral nutrients (Kays, 1999). Excessive application of nitrogen results to reduced firmness and increase the postharvest decay. Most important mineral nutrients is calcium whose deficiency may induce wide range of postharvest disorder in horticultural crops (Shear, 1975). Some of the disorder includes bitter pit in apple, blossom end rot in tomato and capsicum etc. However, calcium deficiency can be overcome by spraying calcium salt during fruit development or by postharvest dipping/ drench treatment (Hewett, et.al, 1991). Foliar application of calcium is considered beneficial as it increase firmness of fruits as well as extends postharvest life. However, high amount of calcium uptake is also consider harmful to plants as it reduces respiration rate and ethylene production (Singh et.al, 2013).

Along with these chemical fertilizers, organic materials are also equally important. Vermi-compost are consider essential inputs to enhance productivity of crops. Organic management practices is considered to be effective as it improves the fruit eating quality.

2.5 Cultural Practices

All cultural practices have direct influence on final quality of the crops. Various cultural operations like use of suitable cultivars, irrigation, mulching, training/pruning, fertilization, soil management, application of growth regulators, phytosanitary control influence nutrient and water supply to plant, which in turn affect nutritional quality of harvested crops.

2.5.1 Planting Density

Planting density affect both quality and quantity of the horticultural products. High planting density increase competition among plants, reduce light penetration which ultimately reduce quantity and quality of produce. Similarly, low planting density results to larger fruit size, better color but may have short shelf life as larger size fruits are more sensitive to physiological disorder. (Mendlinger, 1994) reported that increase in planting density in muskmelon cause decrease in the total soluble solids content.

2.5.2 Irrigation

Adequate amount of moisture in soil during pre-harvest period is essential for maintaining postharvest quality of crops. Moisture stress during growing season affect fruit size, quality leading to soften or dehydrated fruits that are prune to decay during storage. On the other hand, vegetables facing water excess during growing season cause dilution of soluble solids and acids affecting nutritional quality and flavor (Prussia, 1993). Water stress on plants not only decrease productivity of crops but also accelerate fruit ripening (Henson, 2008).

2.5.3 Soil Factors

To maintain good, quality and sustainable soil health is the primary goal for organic production. Achieving these goal directly provides benefits to postharvest quality of horticultural crops. Similarly, soil texture also affect postharvest quality of certain crops. For example, carrot grown on muck soils shows greater concentration of terpenoids which is the chemical that imparts bitter flavor than those grown on sandy soil (Simon, 1985).

2.5.4 Pruning and Thinning

Pruning and thinning is an important cultural practices which help to determine crop load and fruit size that influence nutritional composition of fruits. It also help to reduce crop load and increase growth and development of fruits. This operation helps to reduce competition among plants or fruits, increase light penetration thus promoting good balance between vegetative and fruits parts which results to improved quality products. Proper pruning is very essential as it helps to remove unwanted, diseased and damaged parts of the plants.

2.5.5 Growth Regulator

The use of growth regulator does not directly effects the composition of fruits but also cause indirect effect by delay or accelerated maturity. Poor management of plant protection programs leads to poor quality and reduced yield. Growth hormones like IAA, GA_3, BA, growth retardants like B-9, Phosphon-D has been reported to improve quality and longevity of flower crops. Effective use of chemicals on plants prevent direct impact of pathogen on extending postharvest life. Therefore, prevention of pre-harvest infection appears more logical way for preventing postharvest losses of horticultural crops (Pathak, 1995).

Along with these pre-harvest factors, there are other several postharvest factors affecting postharvest quality of horticultural crops. Some of them includes pre-cooling, sorting and grading, storage, packaging, transportation etc.

3. Conclusions

Pre-harvest factor have profound influence on postharvest quality and nutritional composition of horticultural crops. Quality deterioration of produce started right after harvested and continued till consumed. The success or failure of any business plan associated to horticultural commodity solely depends on management practices of factors affecting its quality. The quality of any produce cannot be improved by the use of any postharvest treatment methods or handling practices but can be maintained. These pre-harvest factors during production should be managed properly for quality production. In order to control the problems of factors affecting postharvest quality of horticultural products, education should be provided to all the farmers, laborers, and merchants about basic science and appropriate method of handling at all postharvest stage could significantly reduce loss in postharvest chain. Most importantly, appropriate government policies and regulations should be implement for the further development. Future research in these factors which are under human control including field management practices, cultivar selection and improvement offers great potential for enhancing postharvest quality of horticultural crops.

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