ROLE OF ABIOTC STRESS FACTORS IN THE POST HARVEST MANAGEMENT OF FRUITS AND VEGETABLES

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ABSTRACT

Presently, one of the major global issue is to provide food to the rapidly expanding population of the world. The problem is more severe in the developing nations. Huge efforts are put in the direction to increase the yield. But comparatively a meager attention is paid to the management of post harvest losses, which result into a major portion of the population deprived of nutrition. Climate changes pose various problems to the plants. Abiotic stress factors such as drought, temperature, salinity, proportion of gases and presence of toxic substances in the environment etc.affect various fruits and vegetables. Though some what difficult to fully understand the mechanism of abiotic stress due to the complexity, yet the management of various stress factors may prove helpful in the better option for the reduction of post harvest losses. Research in the field of abiotic stress factors could be of much help in designing various strategies for the development of fruits and vegetables with enhanced shelf life, better nutritive value and lesser susceptibility to the diseases.

Keywords: Abiotic stress, Climate change, Drought, Post harvest losses, Salinity, Temperature.

I.INTRODUCTION

The main aim of sustainable agriculture is to provide food security to all. A large number of efforts put to increase the yield, are proving to be futile due to various factors. India ranks second in the production of fruits and vegetables, but still is unable to fulfill the daily requirement of a large number of its people. World wide enormous post harvest losses occur annually resulting into the decline in the quality as well as quantity of the produce. Various physical, chemical and biological factors are responsible for such losses. The impact of losses caused by these factors vary on the basis of the type of commodity, climatic conditions, storage facilities etc. Post harvest losses are more in developing countries as compared to developed ones due to poor infrastructure facilities. However, one of the major globally faced challenges in post harvest management is unpredictable climatic regimes. Reduction of post harvest losses is one of the major strategies to assure food safety to the constantly growing population [1].

Fruits and vegetables are mainly consumed for their nutritive value. Appearance and palatable nature are significant factors while procuring from market. There is always a threat to the quality and quantity of the produce from some post harvest pathogens or undesirable climatic conditions [2-4].An understanding of various biotic and abiotic factors responsible for post harvest losses is must. Post harvest deterioration of the commodity may be due to ageing and senescence, microbial attack, physical injury or combination of any of these. [5]. The post harvest changes, especially undesirable ones can not be stopped but can be minimized to reduce the losses. Maintainance and improvement of post harvest management practices is becoming significantly important. [6]. Fruits and vegetables are exposed to number of stress factors at almost all the pre as well as post harvest stages of life. Stress is generally defined as any environmental factor which is potentially unfavourable to the living organisms [7].Environmental changes cause stress in the plants[8]. With exception of decay due to biotic factors, loss in the quality and quantity of the produce can be directly or indirectly attributed to a combination of abiotic stress and stress induced senescence [9]. Unfavourable atmospheric conditions, desiccation, temperature induced injuries during storage, physiological abrasions resulting from packaging and processing are some the examples of abiotic stress factors resulting in to qualitative and quantitative losses of fruits and vegetables [10-11]. Various symptoms of abiotic stress include membrane break down , loss of flavor and texture, weight loss during storage, discoloration especially browning of surface, tissue softening, enhanced rate of respiration and ethylene production , development of off odours. Commonly observed abiotic stresses are related to drought, salinity, extremes of temperature and presence of toxic elements [12].

Proper post harvest management helps to make food available. Post harvest stress treatment have shown to be effective in delaying ageing and senescence, reducing physiological decay by controlling fungal and insect damage and maintain storage quality of the commodity. Thus, post harvest stress treatment can be helpful to improve shelf life and quality retention during the post harvest phase of fruits and vegetables.

Fruits and vegetables are potentially exposed to various abiotic stress conditions during different post harvest stages as handling, storage and marketing. Some of these result into negligible loss in quality . As a consequence it is important to understand the nature and sources of abiotic stress factor affecting food and vegetables. Options for better management and resistance are also available.

In the present article, nature and importance of various abiotic stresses encountered during pre post harvest phase along with the available technology to manage the sensitivity of different fruits and vegetables towards these stresses have been reviewed. For convenience stresses encountered during pre and post harvest phases have been discussed under different headings.

II.PREHARVEST ABIOTIC STRESSES

It is necessary to study the relationship between pre and post harvest stresses as various stresses during the pre harvest stage are directly or indirectly influence the susceptibility of the produce to certain post harvest losses. It has been reported that certain moderate kind of stresses improve stress resistant to some extent by up regulating genes and pathways which render the fruits and vegetables to stresses encountered during different stages of post harvest phase like handling, storage and distribution etc.

2.1.Temperature

The changes in climate pattern are resulting into temperature variations on the earth. Extreme of low as well as high temperature is stressful condition for the plant at both the pre and post harvest stages [13-21]. It has been reported that prior exposure to low ambient temperature is beneficial to retard the chances of chill injury or high heat injury. However, if extremely high or low temperature during the pre harvest stage lead to injury then the chances of such injuries during the postharvest stages are fairer. Thus the temperature at pre harvest stage is of much significance to determine the post harvest stress sensitivity. High temperature of approximately 40*c during the preharvest stage up to harvesting, results into more chances of superficial scald of apple during the storage, while the low temperature minimize the susceptibility to scald.

2.2 Drought

Rapidly occurring changes in the climate patterns are adversely affecting the quantity and quality of fruits and vegetables. Drought is one of the most important environmental constraint to the plant growth and production. There are number of reports on the effects of drought conditions on productivity of various fruit and vegetable crops [22-23], however, a meager reports on effects of pre harvest water stress on responses to stress during post harvest stages, thereby affecting the quality and quantity of the commodities are available. It has been observed that water stress during early stages affect the morphology and physiology of the crops in such a way that it might result in reduction in weight during post harvest phase, especially, during storage. Water stress conditions have both positive and negative effects on a variety of crops including rooted vegetables and fruits borne on the trees. It has been reported that comparatively more trichome formation on the peach fruits is observed under water stress conditions, thereby reducing water losses and hence maintenance of quality of the fruit. Similarly, lowering of post harvest losses during storage has been observed in case of apple and pear, under deficit irrigation conditions [24].It is presumed to occur due to lesser permeability of cuticle as an adaptation in water deficit conditions. Main drawback of deficit irrigation is reduction in the fruit size. Smaller fruit size shows relatively more water loss due to higher surface area to volume ratio. Similarly in case of rooted vegetables like carrot, radish, beet root etc. water stress conditions during the pre harvest stage enhances permeability of cells, resulting into reduction in the weight at later stages.

2.3 Nutrients

Mineral nutrients may also increase or decrease the resistant or tolerance of the plant to the abiotic stress factors like drought, salinity, extremes of temperature etc. or some biotic stress factors like pathogen or pests. However, the knowledge on the effect of nutritional status on the response of plants to abiotic environmental stress factors is still inadequate. Most of the works on the effect of nutrients on the post harvest physiology and morphology of fruits and vegetables mainly have stressed on the post harvest abiotic stress effects. However, availability of nutrients at pre harvest stage is equally significant [25]. Availability of various nutrients like Nitrogen, Phosphorus, Potassium and Calcium etc. play a significant role in the development of post harvest disorders. Nitrogen availability in higher amounts is reported to be associated with reduction in the quality of various fruits and vegetables[26]. Storage discoloration of vegetables like potato and cabbage has been reported to be affected by supply of larger doses of Nitrogen at pre harvest stages. High accumulation of Zinc and Aluminium and nitrate induced Manganeese deficiency due to larger doses of Nitrogen has been reported[27]. Incidence of Black midrib and its severity has also been reported in cabbage during the storage conditions, when the crop was fed with higher doses of Nitrogen. The severity of Black spot of potato was also linked with nitrogen availability, especially in relation to Potassium. Vitamin C content has a great influence on the shelf life of most of fruits and vegetables. Nitrogen deficiency or slightly lower doses of Nitrogen, improves the vitamin C content of fruits and vegetables. Thus, this anti oxidant property can be significantly used to prevent oxidative injuries leading to losses in the quality of the produce during post harvest stages. Potassium nutrition has also shown remarkable reduction in the incidence of damage of potato crop due to internal bruising in response to mechanical stresses imposed during post harvest phase. Desiccation stress leading to weight loss during storage has been reported in case of carrots, when Potassium deficiency was there at pre harvest stages. At levels below 1Mm potassium, weight loss was directly associated with more membrane leakage due to tissue disintegration. However above 1Mm of Potassium in soil medium had shown no effect on weight loss under standard conditions. Role of Calcium nutrition has been studied well in incidence of post harvest diseases of a variety of fruits and vegetables. Role of Calcium as a putative signaling molecule in the development of cross tolerance to abiotic stress has also been suggested [28]. Thus, the role of Calcium in the development of post harvest resistant is somewhat complex. It not only depends upon the availability of Calcium during pre harvest stages but also on the environmental abiotic stresses to which the crop is exposed. Spraying of plum (*Prunus persica* Linn.) with titanium in combination with calcium and magnesium at pre harvest stage resulted in the formation of bigger and firmer fruits with lesser water loss during storage as compared to water spray control.

2.4.Salinity

Effect of saline conditions on the quality of the crops has been studied by a number of workers. Reduction in the fruit size under high saline conditions has been reported in a number of cases. Smaller fruits with more soluble solids have been reported in case of tomatoes. This might be due to increased susceptibility to the post harvest loss i.e. desiccation stress occurring as a result of greater surface area to volume ratios. Though, there is no clear cut information available the literature to confirm the greater desiccation stress among the tomatoes grown in high saline conditions, yet firmness of the fruits is lowered, when salinity level is enhanced.

2.5.Light

Availability of light during pre harvest stage, greatly influence the characterstics of various fruits and vegetables [29-32]. Effect of high light intensity are considered to be closely related to the high temperature. However, it has been reported that high ambient temperature resulted in increased susceptibility of the apples to superficial scald in the cold storage, while the same was greatly lowered when plants were exposed to low light conditions during the pre harvest stage. Mostly, scald was reported only in the sun exposed surfaces of the susceptible varieties of the apple. Reduction in the fruit size of tomato was observed when the crop was grown under ambient low levels of light, leading to more chances of desiccation stress development. Reduction in the shelf life was observed in case of cucumbers grown in green house conditions due to lowered chlorophyll content in the skin of cucumbers. Lower levels of ascorbate has also been reported in many fruits and vegetables grown under green house conditions [33]. Reduced levels of ascorbate make the produce more sensitive towards the post harvest stresses, there by boosting the chances of decay .It might be due to the fact that ascorbate content in linked to higher levels of stress tolerance. In case of lettuce, shelf life of the lettuce exposed to mechanical stress, i.e., fresh cut lettuce is much lesser in the crop when grown under low light conditions as compared to the crop grown under optimal light conditions.

III. POST HARVEST ABIOTIC STRESSES

3.1 Mechanical injuries

Fruits and vegetables are exposed to a variety of mechanical injuries during harvest as well as at different stages of post harvest phase like transport, storage and marketing etc. The mechanical injuries may be due to bruises, cuts or punctures. These generally result into increase in the rate of respiration, enhanced production of ethylene and phenolics, ultimately causing tissue disintegration at the site of injury. A large number of factors such as maturity of the commodity, water potential, temperature, tissue organization at the site of injury etc. affect the severity and size of the injury. Injuries resulting as a cut occur frequently at the time of harvesting and are more common in the machine harvested crop as compared to the crop harvested manually. However, impact caused injuries are commonly reported during the post harvest stages such as transport, storage, packaging or processing etc.

3.2. Temprature

Use of heat treatment for the disinfection and disinfestations of various fruits and vegetables is commonly practicised method. However, it has been observed that break in the cool chain temperature fuels up climacteric changes and tissue softening in a number of fruits and vegetables, thereby shortening their shelf life. It was observed in case of apples that effects of any break in the temperature were noticed only when the crop was harvested at pre climacteric stage ,while minimal effects were seen in case of apples harvested and stored at post climacteric stage [20] 2008]. Crops grown in the tropical and sub tropical regions have another temperature related issue, i.e. chilling injury susceptibility. Most of the fruits and vegetables especially, rooted and tuber type are more susceptible to the chilling injuries. There are a number of changes such as surface pitting, internal browning, tissue softening and mealiness etc. oftenly associated with the indication of chilling stress effects.

3.3. Desiccation

Water loss during the post harvest stage leading to deterioration of the quality of the fruits and vegetables is another important issue. It results in wilting and rapid rate of senescence leading to reduction in the quality as well as quantity of the crop. Vapour pressure deficit is the main driving force for the water loss. Greater is the vapour pressure deficit more is the water loss. Water loss can be minimized by storing the crop at appropriate cool temperature with high relative humidity serve the purpose to much extent.

3.4. Ratio of Oxygen and Carbon Dioxide

Low oxygen and high Carbon dioxide stress is of major concern at the time of post harvest handling and storage [35-37]. Low oxygen levels result into stress induced changes in the metabolism and resulting into metabolite accumulations. Acute low oxygen injury is expressed only when the tissue is re- aerated, resulting into an uncontrolled oxygen burst. The latter leads to membrane injury,protein denaturation and lipid peroxidation. Different fruits and vegetables depending upon temperature, anatomy, physiology and presence of gases like Carbon dioxide, carbon monoxide, methane and methane etc, have variable thresholds of low oxygen stress. High Carbon dioxide levels competitively inhibit ethylene binding and action, resulting into delayed senescence in climacteric fruits. High carbon dioxide levels inhibit succinate dehydrogenase, there by distrupting TCA cycle and aerobic respiration. Various physiological disorders such as Surface bronzing of apples, Brown core of apples and pears, black heart of potatoes, brown stain of lettuce etc are associated with higher levels of carbon dioxide. Chilling stress, susceptibility to pathogen attack and ethylene induced disorders can also be modulated with high Carbon dioxide.

IV. RESULTS AND DISCUSSION

Harvested fruits and vegetables are exposed to numerous abiotic stresses. During various stages of post harvest phase such as transportation, storage and marketing. These abiotic stresses have negative impacts in some cases, while positive ones in others. Abiotic stresses are major determinants of nutritional value, appearance and quality of the produce. It is important to understand the basis of molecular and biochemical response networks to various stress factors encountered in pre as well as post harvest stages. It is significant to note that appropriate stress management may prove beneficial in enhancing the tolerance to stress and improving the shelf life and nutritional value of the crop.

V. CONCLUSION

A variety of morphological, physiological and biochemical changes are shown by plants in response to variouss abiotic stresses. Most of these changes lower plant's exposure to the stress or limit damage and facilitate recovery of the impaired systems. However, complete understanding of abiotic stress responses is a difficult task due to complexity, inter relationship and variability in the molecules and mechanisms involved. A number of future strategies regarding the enhancement of yield, improvement in the quality of various fruits and vegetables can be planned and executed with proper understanding of the abiotic stress factors and their role. Research in this arena has a number of prospects and challenges for the future.

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