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# IMPACT OF PHYTOHORMONES ON PHYSIO-CHEMICAL PROPERTIES OF TROPICAL AND SUBTROPICAL FRUITS: A REVIEW

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## Abstract

The plant hormones are exceptionally important agent in the combination of developmental events. Plant growth regulators are generally used to advance the quality of fruits including physio-chemical properties of fruits. Their role in extending shelf life of harvested fruits cannot be denied. Environmental influences often put inductive effects by tempting changes in metabolism and circulation inside the plant. Moreover they also control countenance of inherent genetic prospective of plants. Control of genetic manifestation has been established for the plant hormone at transcriptional and translational stages. Also, hormone receptors and binding proteins have been recognized on surface of the membrane that is precise for various hormones. The use of PGR has become a significant part of agro-technical processes for many cultivated particularly for fruit plants.

***Key words:*** Ascorbic acid, naphthalene acetic acid, salicylic acid, physio-chemical properties, tropical fruits, sub-tropical fruits

## Introduction

Plant growth regulators or phytohormones are organic ingredients formed naturally in higher plants, governing growth or other physiological events at a location remote from its site of production and dynamic in little quantities. Thimmann suggested the term *Phyto-hormone* as these hormones are produced inside the plants. They include auxins, gibberellins, cytokinins, and ethylene. They also include various growth retardants and growth inhibitors. Firstly auxins, then gibberellins and cytokinins were also discovered respectively. During the last 50-60 years extensive research work has been done in the world on several traits such as varieties, irrigation, propagation techniques, training and pruning etc. to enhance the quality and yield of fruits.

### 1. Significance of NAA

Naphthalene acetic acid is a synthetic auxin plant hormone that is routinely used for the vegetative propagation of plants from stem and cutting. The effect of NAA on plant growth is greatly dependent on the time of admission and concentration. NAA has been shown to greatly increase cellulose fiber formation in plants. In majority of fruit plants, fruit drop is controlled by spraying of NAA in different fruit crops in different concentrations. It is applied after blossom fertilization.

#### Effect of NAA on Fruit Size

Vidya *et al*. (2016) revealed in fruit pomegranate cv. Bhagwa that NAA@40 ppm was very useful in increasing fruit length (8.66cm), fruit diameter (8.71cm), fruit weight (262.23g). Meena *et al*. (2013) proved that naphthalene acetic acid (NAA) was very effective in improving the length of the fruit (23.11 & 27.95%) and fruit width (20.15 & 17.9%) in ber (*Zizyphus mauritiana* L.) fruits of cv. Gola. resulted in highest improvement in total yield of the plant.

#### Effect of NAA on Fruit Weight

Kacha *et al*. (2012) explored the effect of NAA in phalsa (Grewia asiatica L.) and revealed NAA improved fruit weight. Painkra *et al*. (2012) obtained highest fruit weight with NAA @ 40ppm. Garasiya *et al*. (2013) deliberated that an NAA treatment enhances weight, volume, diameter of the fruit along with yield. Meena *et al*. (2013) established that naphthalene acetic acid (NAA) was very effective in improving length (23.11 & 27.95%) and fruit width (20.15 & 17.9%) in ber fruit (*Zizyphus mauritiana* L.) cv. Gola.

**Effect of NAA on Fruit Colour**

Amoros *et al*. (2004) described that organoleptic properties of loquat fruit were improved by NAA treatment. Phani *et al*. (2015) found that naphthalene acetic acid (NAA) improved skin colour (Hunter 'L', 'a' and 'b') but progressively in guavas with the advancement of storage period. Mature green fruits exhibited encouraging results in controlling the physiological and biochemical changes that are associated with colour turning stage. Gill *et al.* (2009) observed in ber that NAA causes improvement in colour of the fruit.

**Effect of NAA on Fruit Firmness**

Niranjala *et al*. (2001) stated related outcomes and directed that fruit firmness was higher in bananas preserved with acetic acid. The acetic acid also deferred peel colour improvement. Kher *et al*. (2005) perceived that NAA caused advanced the fruit firmness of guava fruit cv. Sardar. Wahdan *et al*. (2011) revealed that SSC and fruit firmness were augmented by NAA treatment in case of mango cv. "Succary fruit.

**Effect on NAA on Physiological Loss in Weight (PLW)**

NAA treated fruits exhibited minor spoilage during cold storage and it might be due to interruption of senescence process and less-temperature inside the storage. These conditions are problematic to establish and breed inside the cold storage. Similar results also reported by Youlin *et al*. (1997) in storability. Dikki *et al*. (2008) detailed that the pre-harvest application of NAA resulted in improved retentive of the physico-chemical properties i.e., physiological loss in weight, fruit firmness, TSS, total sugar, (non-reducing sugar and reducing sugar) along with extending the shelf life of papaya.

**Effect of NAA on Spoilage Percentage-**

Rizk-Alla *et al*. (2011) established that NAA application withdraw the rate of declining of grapes in cold storage by reducing weight loss, decay (%) and total spoilage. Kaur & Bal (2014) detailed that the spoilage was much less in fruits in which ascorbic acid treatment in involved.

**Effect of NAA on Total Soluble Solids (%)**

Vidya *et al.* (2015) detailed in pomegranate cv. Bhagwa that NAA was effective in augmenting TSS. Katiyar *et al.* (2008) verified that NAA resulted in highest TSS content. Kachave and Bhosle (2009) investigated on Kagzi lime revealed that NAA + micronutrients mixture spray was the premium treatment for enhancement in TSS.

**Effect of NAA on Acidity (%)**

Khunte *et al.* (2014) verified lowest acidity in plants sprayed with NAA. Ibrahim *et al.* (2015) recognized that NAA treatment resulted in the improved amount of total sugar, total soluble solids and vitamin C while the amount of titrable acidity was declined. Kuldip *et al.* (2016) revealed that there was no considerable decrease in acidity except NAA treatment in case of pomegranate. Ghosh *et al.* (2016) discovered in pomegranate that acidity was lowest with NAA.

**Effect of NAA on Vitamin C-**

Rajput *et al.* (2015) stated that maximum quality of guava fruit cv. Lucknow-49 was noted with NAA application. Kuldip *et al.* (2016) discovered that NAA enhanced the ascorbic acid content in pomegranate. Osama *et al*. (2015) proved that NAA boosted fruit set and fruit retention along with fruit quality traits of Keitt mango trees. Lal *et al*. (2015) disclosed the effect of NAA treatment on fruit drop and storage quality of Kinnow. They established that NAA application leads to minimum loss of TSS and total sugars.

**2. Significance of Salicylic Acid**

Salicylic acid is widely used in fruit production and it is included in plant hormones group. It is supposed to have varied functions in plant body. Salicylic acid being an endogenous growth regulator from phenolic assembly has been widely used for quality enhancement. Literature has remarkably claimed the role of salicylic acid and its influence on physiological or biochemical developments including ion uptake, enzyme activity, membrane penetrability, heat production, growth and development.

**Effect of SA on Fruit Size**

Javaheri *et al*. (2012) found that salicylic acid plant growth regulator improved the diameter of fruit skin. Various researchers have noted that SA can be used to improve physical properties of fruits such as size and weight (Marzouk and Kassem, 2011). Champa *et al*. (2015) stated that in grape *cv*. Flame Seedless salicylic acid hastened fruit maturity along with large size of berries.

**Effect of SA on Fruit Weight**

Bassem (2015) discovered in "Crimson Seedless" grapes that SA treatments significantly improved visual look of berries and augmented berry firmness during cold storage period. Salicylic acid played a significant role in defining berry quality such as colour, flavor and bitterness (Chamkha *et al*. 2003). Salicylic acid improved physical properties of fruits such as weight and firmness (Srivastava and Dwivedi, 2000; Zhang *et al*. 2003; Shafiee *et al*. 2010). Champa *et al*. (2015) stated that

salicylic acid (SA) improves the cluster weight (Berry weight), length and breadth in clusters in grapes of CV Flame Seedless.

**Effect of SA on Fruit Colour**

Champa *et al*. (2015) stated that in Flame Seedless berries mature, colour modified from a pure green to yellow and finally to red. SA treatment detailed a lower L* and b* values along with higher a* value that fruit seems darker and redder. Supapvanich (2014) established that pre harvest application of SA declined the loss of greenness range during storage. They stated that SA had no effect on the deviations in lightness and yellowness worth.

**Effect of SA on Fruit Firmness**

Marzouk *et al*. (2011) established improved firmness in grape cv Thompson seedless after application of salicylic acid. Ranjbaran *et al*. (2011) found that SA prolonged the storage life of grapes. All applications of SA were effective to reduce water loss and softened berry percentage.

**Effect of SA on Physiological Loss in Weight (PLW)-**

Exogenous treatment of SA at acceptable concentrations to susceptible fruits could improve resistance to various pathogens and other related post-harvest decay (Asghari, Hajitagilo, & Jalili, Marandi, 2009, Hajitagilo, & Shirzad, 2007; Babalar *et al*. 2007). Champa *et al*. (2015) discovered in grape cv. Flame Seedless that salicylic acid (SA) exhibited decent performance regarding organoleptic properties along with reduction in weight loss. Zheng *et al*. (2002) worked in mandarin (*Citrus reticulate* Blanco) on trifoliate rootstocks (*Poncirus trifoliata* L) and proved that endogenous applications of salicylic acid peaked in October at the highest and then dropped gradually during postharvest storage.

**Effect of SA on Spoilage Percentage**

Marzouk *et al.* (2011) found cluster and berry quality characters as well as vine yield were enhanced by salicylic acid treatment**.** Xinhua *et al*. (2011) discovered in pineapple (*Ananas comosus* L. 'Comte de Paris') that salicylic acid resulted in less fruit spoilage of the fruit. They also explained that that salicylic acid spray or immersion applications delayed the decline of ascorbic acid (AA) content. Sayyari *et al*. (2009) directed an experiment with which they discovered that SA applications were very effective in decreasing CI and electrolyte discharge in the shell of pomegranate, as well as ascorbic acid impairment.

**Effect of Salicylic Acid on TSS**

Barakat *et al.* (2015) recognized that SA had higher TSS in Valencia fruits. They recorded that acidity was reduced in all cases. Sarikhani *et al*. (2009) discovered that SA had no effect towards total soluble solids in table grapes. While Yeganeh *et al*. (2013) recorded that SA expressively altered the post-harvest management of grapes with respect to all assets including TSS and fruit general quality.

**Effect of SA on acidity**

Muhammed *et al*. (2012) specified that SA treatment had no interference towards titrable acidity. Dastjerdi *et al* (2014) stated that salicylic acid treatment changes acidity in mango. Barakat *et al.* (2015) discovered that camphor + jasmine oil + salicylic acid treatment significantly decreased acidity (%) in Valencia Orange during Storage.

**Effect of SA on Vitamin C**

Junmatong *et al.* (2015) stated that augmented ascorbic acid levels were recorded in storage after SA treatment. Aghaeifard *et al*. (2016) disclosed that salicylic acid treatment SA treatment postponed the decline the level of ascorbic in pineapple fruit. Lu *et al*. (2011) proved that SA treatments had no soluble solids content and titrable acidity, but deferred the decline of ascorbic acid in winter pineapple fruit.

**3. Significance of Ascorbic Acid**

Ascorbic acid (vitamin C) is an important constituent of plants. It has anticipated functions in photosynthesis as an enzyme cofactor and in governing cell growth. It is an important antioxidant and in association with other constituents of antioxidant organization, defends plants from oxidative destruction resultant from aerobic metabolism, photosynthesis and various pollutants like ozone, saline stress and heavy metal. Consequently, there is a need to improve our considerate about this enigmatic molecule since, it could be intricate in a wide range of developmental phenomenon's as well as works against real pressure in order to normalize improved growth and development.

**Effect of Ascorbic Acid on Fruit Size**

El-Sayed *et al.* (2000) described that application (foliar spray) of ascorbic acid in grapes cultivar Flame seedless caused improvement in berry dimensions. Ahmed *et al.* (2007) disclosed that application of ascorbic acid resulted into proliferation in dimensions of the fruit. Fayed (2010) detailed in grapevine that treatment of ascorbic acid resulted in higher shoot length, leaf fresh and dry weights, bunch weight, bunch length, cluster width.

Number of berries/bunch, weight and volume of berry were also influenced in this experiment.

**Effect of Ascorbic Acid on Fruit Weight**

Wassel *et al*. (2007) examined the effect of ascorbic acid on physical and chemical properties of seedless grapevines berries. They noted that there was a well-defined encroachment on yield. They further explained the reason of this advancement. According to them it was either due to weight or increased number of clusters per vine due to application of ascorbic acid. Fayed (2010) given foliar application of combined antioxidants (Thiamin + Ascorbic acid and Citric acid) Thompson seedless grapevine cultivar and observed that bunch weight was affected by these application.

**Effect of Ascorbic Acid on Fruit Colour**

Gill *et al*. (2014) detailed that guava fruits conserved standard organoleptic rating up to 21 days of cold storage when ascorbic acid was applied. It was discovered that ascorbic acid (100 ppm) was the most effective management.

**Effect of Ascorbic Acid on Fruit Firmness**

Niranjala *et al.* (2001) stated related outcomes and directed that fruit firmness was higher in bananas cured with citric acid. Fayed (2010) studied that foliar treatment of ascorbic acid (along with combination of other antioxidants) gave the lowest berry firmness and acidity in Thompson seedless" grapevine. Gill *et al*. (2014) revealed that ascorbic acid treatment sustained meaningfully advanced average fruit firmness in guava fruit.

**Effect of Ascorbic Acid on Physiological Loss in Weight (PLW)**

Kaur & Bal (2014) obtained the lowermost PLW (6.08%) in fruits after treatment with ascorbic acid. Gill *et al*. (2014) disclosed that guava fruits recorded the lowermost mean PLW (5.27% and 4.48%). It was further observed that the average PLW reduced expressively ($p< 0.05\%$) with the increase in application of ascorbic acid from @ 25 to 100 ppm. Ramparasad *et al.* (2004) described that when grapes berries were treated ascorbic acid @1000 ppm resulted into lower cumulative physiological loss in weight. It has been established that ascorbic acid application expressively declined the post-harvest losses, augmented quality and extended shelf-life of the fruits. (Jayachandran *et al*. 2007).

**Effect of Ascorbic Acid on Spoilage Percentage**

Kaur & Bal (2014) verified that there is much less spoilage and augmented fruit firmness when ascorbic acid treatment is applied. They recorded that spoilage was increased as the duration of the storage was proceeded in case of ber fruit. Ahmed (1998) described that ascorbic acid significantly improved consumer satisfactoriness and decreasing post-harvest losses in mango. Banik *et al*. (1988) and Siddiqui and Gupta (1995) who also informed minimum spoilage in ber fruits treated with plant growth regulator ascorbic acid.

**Effect of Ascorbic Acid on Total Soluble Solids (%)**

Fayed (2010) discovered that TSS was high in case of ascorbic acid treatment. Al-Douri and Al-A'areji (2012) revealed in pomegranate that AA was not influential on TSS. El-Sayed *et al*. (2000) detailed that ascorbic acid in Flame seedless grapevines was accountable for improving chemical features like TSS. Mansour *et al*. (2010) deliberated the effect of ascorbine on properties of four mango cultivars namely Zebda, Awase, Alphonso, Taimour and discovered that enhancing antioxidants concentration had worthless effect on TSS.

**Effect of Ascorbic Acid on Acidity (%)**

Khiamy (2003) confirmed that ascorbic acid was supportive in reducing total acidity. Same results were obtained by Ahmed *et al*. (2007). Fayed (2010) deliberated foliar application of ascorbic acid resulted in lowest berry acidity in grapevine cv Thompson seedless. Al-Douri and Al-A'areji (2012) revealed in pomegranate that ascorbic acid had no effect on acidity. Gill *et al.* (2014) discovered that acidity in guava trailed a declining trend throughout the storage. Ascorbic acid application sustained expressively higher acidity.

**Effect of Ascorbic Acid on Vitamin C-**

Mansour *et al*. (2010) detailed the influence of ascorbine on properties of four mango cultivars viz. Zebda, Awase, Alphonso, Taimour and explained that enhancing antioxidants concentration had insignificant result on vitamin C content.

## Conclusion

Plant growth regulations good prospective to increase productivity of fruits by bringing out a change in hormonal status of the plant. Among various growth regulators NAA is widely used and it effects every aspect of the fruit production. Salicylic acid has been known to be present in some plant tissues or also applied exogenously but has recently been accepted as effective PGR which play a vital role in regulating a number of plant functional processes. The application of plant growth regulator can provide significant economic advantages to fruit growers. Treatment with ascorbic acid resulted in enhancement

of yield which is main concern of the fruit growers. Besides yield it is greatly helpful in improving fruit size along with other chemical fruit properties like TSS, total sugars and lessening the total acidity. Not much work is done on ascorbic acid towards its effect on fruit aspects.

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