



# Effect of Growth Retardants and Other Chemicals on the Enhancement of Shelf Life of Fruits

V. Phani Deepthi\*

\*Teaching Associate, College of Horticulture, Dr.YSR Horticultural University,  
Anantharajupet, Kadapa Dt. Andhra Pradesh, 516105 India  
\*deepthivellaturi@gmail.com

**Abstract** – It is well documented in the literature that pre and post harvest applications of growth retardants and various chemicals extend the shelf life of many fruits by maintaining firmness and minimizing the rate of respiration, protein breakdown and disease incidence. This review provides a comprehensive overview of the basic and applied aspects of growth retardants and other chemicals used in regulation of fruit ripening and senescence. The latter part of the review deals with their current and potential uses on various tropical and sub-tropical fruit crops.

**Keywords** – Growth Retardant, Shelf Life, Respiration, Ethylene, Storage.

## I. INTRODUCTION

India is the **second** largest producer of fruits with an annual production of **88.97MT** from **7.21Mha** area, which accounts for 10% of the total world's fruit production.

Post harvest losses of fruits account for about, **25-30%** of the total fruits produced per year in India. Hence, various chemicals have been used to hasten/ delay ripening, to reduce losses and to improve and maintain the color and quality by slowing down the metabolic activities of the fruits ultimately leading to increased shelf life and marketability for longer periods, and the effectiveness of such treatments might be influenced by the combination of time and temperature.

These chemicals arrest the growth and spread of various microorganisms by reducing the shriveling which leads to an increased shelf life and maintain the marketability of the fruit for a longer period. Hence can be applied either as **pre** harvest application (spray/ dip) in non-climacteric fruits or at **post** harvest stage (spray/ dip/ pressure/ vacuum infiltration) in climacteric fruits or both in some cases.

### Means to improve shelf life in fruits

Shelf life in fruits can be improved by means of several ways, among which 4 are important, they are,

1. Reduction in respiration rate
2. Prevention of autocatalytic synthesis of ethylene
3. Delay in post harvest decay of the produce during storage
4. Prevention of self-breakdown of tissues

### Growth retardants and other chemicals that delay ripening

They can be classified into several groups, such as,

1. **Polyamines** – Putrescine, Spermidine & Spermine
2. **Growth retardants/ inhibitors** - CCC, MH, PP333, Alar, Diamiozide.....
3. **Morphactins** – chloro-furenol methyl ester
4. **Organic Acids** – Citric acid, Acetic acid, Ascorbic acid

5. **Calcium salts** –  $\text{CaCl}_2$ ,  $\text{Ca}(\text{NO}_3)_2$ , Ca lactate and Ca propionate
6. **Sodium carbonate, bicarbonate and KCl salts**
7. **Boron**
8. **Pure  $\text{N}_2$  gas**
9. **Fungicides** – several systemic and non-systemic fungicides
10. **Ethylene inhibitors ... they can be classified into 4 groups like,**
  - a. **Free radical quenchers** – benzoic acid, SB (sodium benzote), sodium dithionate
  - b. **Ethylene biosynthesis inhibitors** – Al,  $\text{CoCl}_2$ , AVG (amino ethyl vinyl glycine) (ReTain<sup>TN</sup>), AOA (amino oxy acetic acid), 8-HQC/S (8- hydro quinoline citrate/sulphate)
  - c. **Ethylene absorbents** -  $\text{KMnO}_4$ ,  $\text{HgOCl}_2$  (mercuric per chlorate), perlite, activated charcoal (Purafil, Ethysorb<sup>TN</sup>)
  - d. **Ethylene action inhibitors** –  $\text{AgCl}_2$ ,  $\text{AgNO}_3$ , STS (silver thio sulphite), DCAP (diazo cyclo pentidine), 1-MCP (methyl cyclo propene) (Ethylbloc<sup>TN</sup>), 2,5-norbornadiene (gaseous cyclic olefin)

### 1. Polyamines

Polyamines delay senescence of tissues, probably through their effects on membrane stabilization and cell wall rigidification. These effects are opposite to ethylene, which has a common precursor, S- adenosyl methionine (SAM), hence exogenous application of polyamines may extend the shelf life of fruits by inhibiting the ethylene production and respiration rate with minimal or no detrimental effects on fruits quality (Kakkar and Rai, 1993).

Malik and Singh (2005) studied post harvest dipping of mature green mango (cv. Kensington Pride) fruits with various polyamines, viz., Putrescine (PUT), Spermidine (SPD) and Spermine (SPM) at different concentrations (0, 0.01, 0.5 and 1.0 mM). Among all the treatments, 0.5 mM SPM treated fruits exhibited significantly lower ethylene evolution and respiration rates, higher fruit firmness and ascorbic acid contents besides improving shelf life without impairing the fruit quality.

### 2. Growth retardants/ inhibitors

CCC (500 ppm) and Alar (1000 ppm) as pre harvest spray was the most effective in reducing weight loss and decay/rot in grapes cv. Pusa Seedless due to higher arginine to proline ratio (Rao and Pandey, 1980).

**Diaminozide** (N-dimethylamino succinic acid) delays the rate of ripening by suppression of ethylene synthesis.



Diaminozide spray (1000 ppm) two months before harvest extends the harvest time in McIntosh apples.

**Maleic hydrazide** (1000 ppm) as post harvest dip along with wax emulsion coating enhanced the shelf life and quality of mango cv. Banganapalli (Gautam *et al.*, 2003).

**PP333, Hydrogen cyanamide** - delays ripening, optimize harvest timing & extend shelf life.

### **3. Morphactins**

**Chloro-furenil methyl ester** is commonly used morphactin for increasing the shelf life of various fruits.

Post harvest dipping of 'Allahabad Safeda' guava fruits with a morphactin, chloro-furenil methyl ester (100 ppm) was effective in controlling per cent CPWL and chlorophyll breakdown during storage, also increased the shelf life of various fruits.

A combination of benomyl (1000ppm) and morphactin (100ppm) was effective in controlling the decay of guava fruits (Gupta and Mukerjee, 1980).

### **4. Organic Acids**

Citric acid, Acetic acid, Ascorbic acid are commonly used organic acids to improve the shelf life of perishable products, fruits and vegetables to a large extent.

Pressure infiltration of these acids, Citric acid (0.05%), Acetic acid (0.2%) and Ascorbic acid (0.1%) was done to improve the shelf life of banana. Acetic acid (0.2%) was effective in controlling the post harvest diseases, maintained highest fruit firmness and delayed peel color change (Niranjala and Anjani, 2001).

### **5. Calcium salts**

$\text{CaCl}_2$ ,  $\text{Ca}(\text{NO}_3)_2$ , Ca lactate, Ca propionate are most commonly used calcium salts for the improvement of shelf life in several fruits during storage. Calcium chloride ( $\text{CaCl}_2$ ) has a significant impact on the shelf life of fruits and vegetables among other sources of Calcium, it

- Delays aging or ripening
- Slows down the post harvest decay
- Retains firmness of the fruit
- Controls the development of many physiological and storage disorders (esp. in Apple and Mango, which are more susceptible to Ca-related disorders like soft rot, brown heart etc.)
- Increases the calcium content, thus improving the nutritional quality

Pre harvest application of Ca especially  $\text{CaCl}_2$  increased shelf life by maintaining the firmness of fruits (↓ no. cracked fruits) due to increased depositions of Ca pectate in middle lamella of cell walls in fruit (Subburamu *et al.*, 1990).

Post harvest application of  $\text{CaCl}_2$  and  $\text{Ca}(\text{NO}_3)_2$  improves the physiological and physicochemical characteristics of cell wall pectin by reducing the solubilization of uronic acids in the pectin network, thereby firmness of the fruit can be maintained for prolonged periods (Sudha *et al.*, 2007).

### **6. Boron**

Boron is closely associated with Calcium and they produce typically same storage disorders in some fruits, while B' application increases the Ca' uptake and reduces the Ca' related disorders.

Pre harvest foliar sprays of Boron @ 0.25Kg/ha six times at 10 days interval (8wk before harvest) in 'Conference' pears did not exhibit any browning disorders during storage. Fruit firmness and Vit-C content were improved in the Boron treated fruits when compared to control (Xuan *et al.*, 2001).

### **7. Pure $\text{N}_2$ gas**

Short-term anoxic treatments with  $\text{N}_2$  gas act by inhibiting the respiration and ethylene production by the fruit and thereby delaying the ripening related process. It also reduces the activities of softening enzymes, polygalacturonase (PG) and pectin methyl esterase (PME) by protecting stiff pectin macromolecules against demethylation or reduced depolymerization of polygalactouronase enzyme (Yi *et al.*, 2004).

### **8. Sodium carbonate and bicarbonate salts**

2% solutions of SC and SBC solutions alone or in combination of hot water are effective in controlling the post harvest decay and improved the post harvest storage life in clementines. They have inhibitory effect on ethylene biosynthesis, retarded the activity of enzymes responsible for ripening (Larrigaudiere *et al.*, 2002).

### **9. Fungicides**

Pre harvest application of 6 different fungicides like, Bavistin [carbendazim] (500 ppm), Dithane M-45 [mancozeb] (500 ppm), Topsin M [thiophanate-methyl] (500 ppm), Captan (500 ppm), Cuman L [ziram] (500 ppm), Ridomil MZ [mancozeb + metalaxyl] (500 ppm), and GA3 (200 ppm), Cycocel [chloromequat] (500 ppm), MH [maleic hydrazide] (500 ppm), calcium nitrate (1.0%) and calcium chloride (1.0%), on the shelf life and quality of ber [*Ziziphus mauritiana*] cv. Gola was evaluated. At 8 days of storage, Calcium nitrate gave the lowest physiological weight loss, decay loss and acidity, and the highest fruit firmness, total soluble solids content, ascorbic acid content (Saran *et al.*, 2004).

### **10. Ethylene inhibitors**

They are inhibitors of ethylene synthesis, they can be classified into 2 major groups, and they are,

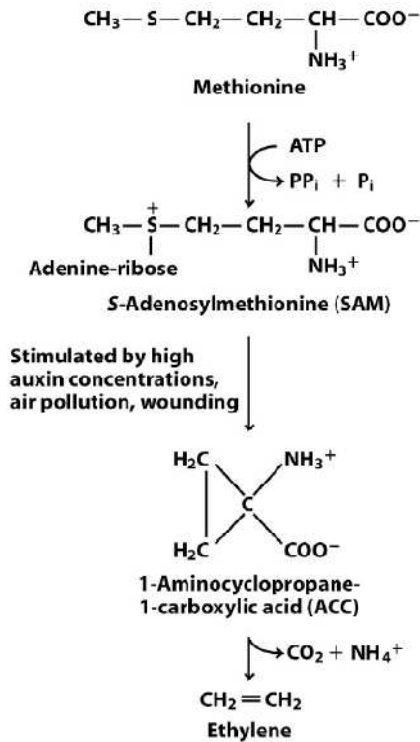
#### **ACC synthase activity inhibitors**

These chemicals or compounds inhibit the activity of the enzyme, ACC synthase, thereby reduced or no synthesis of SAM, hence reduced or no synthesis of ethylene. They are AVG and AOA.

#### **ACC oxidase activity inhibitors**

These chemicals or compounds inhibit the activity of the enzyme, ACC oxidase, thereby reduced or no synthesis of ACC, hence reduced or no synthesis of ethylene. They are  $\text{CoCl}_2$  and Al.

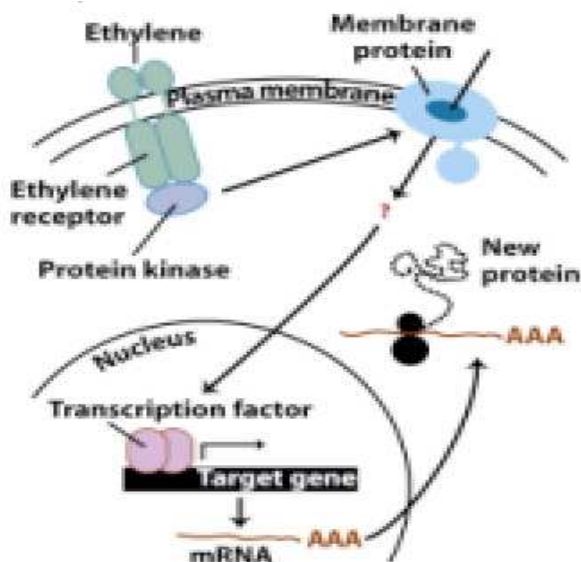
This flow chart shows the bio-synthesis of ethylene in plant cells from the precursor, methionine. These inhibitors block the enzymes action responsible for ethylene production.



#### At cellular level ...? They act by,

1. Blocking the binding sites of ethylene receptors
2. Blocking the synthesis of ethylene

Thereby preventing ethylene effects in plant tissues for extended periods....!



#### AVG

'ReTain' is the commercial formulation of amino ethoxy vinyl glycine (AVG). It acts by blocking ACC synthase activity- inhibiting the synthesis of ethylene. Exceptionally a useful harvesting management tool for apple & pear growers. It must be applied several weeks (3-4 weeks) before fruits are mature to hold ethylene production. It delays harvesting & fruit drop by 7-10 days. It also delays colour development, starch degradation and firmness loss.

#### 1-MCP (1-methylcyclopropene)

1-MCP inhibit the fruit ripening by binding irreversibly to ethylene binding sites, as a result ethylene is unable to bind and elicit subsequent transduction and translation, thus leading to inactivation of MAP kinase cascade and finally the loss of physiological sensitivity to ethylene.

#### Concluding remarks...

Consumer demands and government regulations in the last few years have led to research on developing and improving the post harvest protection of horticultural produce to minimize the PH losses in especially developing countries by the judicious use of chemicals to delay ripening.

Therefore, these chemicals should be at applied at safe limits, which renders low or no mammalian toxicity and adverse environmental impact..!

#### REFERENCE

- [1] Gautam, B., Sarkar, S.K. and Reddy, Y.N. (2003). Effect of post harvest treatments on shelf life and quality of banganapalli mango. *Indian J. Hort.*, **60(2)**: 135-139.
- [2] Gupta, V.K. and Mukerjee, D. (1980). Prolonging shelf life of 'Allahabadi Safeda' guava fruits with a morphactin and benomyl. *Indian J. Hort.*, **37**: 163-166.
- [3] Yi, C., Jiang, Y. M., Sun, J., Luo, Y. B., Jiang, W. B. and Macnish, A. (2004). Effect of short term N<sub>2</sub> treatments on ripening of banana fruit. *J. Hort. Sci. Biotech.*, **81(6)**: 1025-1028.
- [4] Kakkar, R.K. and Rai, V.K. (1993). Plant polyamines in flowering and fruit ripening. *Phytochemistry*, **33**: 1281-1288.
- [5] Larrigaudiere, C. (2002). Storage performance of clementines treated with hot water, sodium carbonate and sodium bicarbonate dips. *J. Hort. Sci. Biotech.*, **77(3)**: 314-319.
- [6] Malik, U. and Singh, Z. (2005). Pre storage application of polyamines improves shelf life and fruit quality in mango. *J. Hort. Sci. Biotech.*, **80(3)**: 363-369.
- [7] Niranjala, P. and Anjani, M. (2001). Reponse of bananas to post harvest acid treatments. *J. Hort. Sci. Biotech.*, **76(1)**: 70-76.
- [8] Rao, M.M. and Pandey, R.M. (1980). Amino acid metabolism during ripening and storage of pusa seedless grapes treated with ethrel and growth retardants. *Indian J. Hort.*, **37**: 39-45.
- [9] Subburamu, K., Singaravelu, M., Nazar, A. and Irulappan, I. (1990). Pre-harvest spray of Calcium in grapes. *South Indian Hort.*, **38**: 268-269.
- [10] Sudha, R., Amutha, R., Muthulaksmi, S., Babyrani, W., Indra, K. and Mareeswari, P. (2007). Influence of pre and post harvest chemical treatments on physical characteristics of sapota. *Res. J. Agric. Biol. Sci.*, **3(5)**: 450-452.
- [11] Xuan, H., Streif, J., Pfeffer, H., Dannel, F., Römheld, H. and F. Bangerth (2001). Effect of per harvest boron application on the incidence of CA- storage related disorders in 'Conference' pears. *J. Hort. Sci. Biotech.*, **76(2)**: 133-137.
- [12] Saran, P.L., Lal, G., Jat, R.J. and Singh, R.V. (2004). Effect of pre-harvest foliar application of different chemicals on shelf life and quality of ber (*Zizyphus mauritiana* Lamk) cv. Gola. *Haryana J. Hort. Sci.*, **33(1-2)**: 71-73.