# Postharvest Ethylene: A critical factor in quality management.

By Jenny Jobling

Ethylene plays a role in the postharvest life of many horticultural crops. Ethylene is a colourless gas with a faint sweetish smell that is the naturally produced ripening hormone of some fruit. It is also produced as an exhaust gas from petrol combustion engines. This article will outline some of the beneficial and negative effects of ethylene on the quality of fresh produce.

The important role of ethylene as a plant growth regulator has only been established over the last 50 years but its effects have been known for centuries. Reid (1992) gives the example of how the flammable gas used for lighting street lamps in Europe contained added ethylene so the lamps burnt with a yellow flame. It was observed that plants growing near any leaky pipes showed some strange growth patterns such as premature leaf fall and death of their flowers. Observations like those spurred the research that continues today to determine the effects of ethylene on plant growth and development.

There are two classes of fresh produce in terms of ethylene production. There are climacteric products, mainly fruit that produce a burst of ethylene as they ripen, as well an increase in respiration and there are the non-climacteric products that do not increase ethylene production when they ripen. The more obvious way of establishing which class a product fits in to is whether or not the product ripens after harvest. Products that ripen after harvest are classed as climacteric and they typically ripen by softening significantly, by changing colour and become sweeter, examples are bananas and nectarines. Non-climacteric fruits do not change significantly after harvest. They will soften a little, lose green colour and develop rots as they become old but they do not change to improve their eating characteristics. Non-climacteric crops include leafy vegetables, strawberries and grapes.

Table 1: Examples of climacteric and non-climacteric products.

| **Climacteric (Ethylene producing)** | **Non-climacteric (Non ethylene producing)** |
|---|---|
| Apples, pears, quince | Cherry, blackberry, strawberry |
| Apricot, nectarine, peach | Eggplant, cucumber, pepper |
| Mango, avocado, banana | Lemon, orange, mandarin |
| Tomato, sapodilla | Water melon, honey dew melon |
| Rock melon, passionfruit | Grape, lychee, loquat |

* From Kader (1992). Postharvest Technology of Horticultural Crops. p.16.

**Beneficial Postharvest Applications**

Table 2: Ripening conditions for some fruit using ethylene.

| Fruit | Temperature ($^{o}$C) | Ethylene (ppm) | Treatment time (hrs) |
|---|---|---|---|
| Avocado | 18 - 21 | 10 | 24 - 72 |
| Banana | 15 - 21 | 10 | 24 |
| Kiwifruit | 18 - 21 | 10 | 24 |
| Persimmon | 18 - 21 | 10 | 24 |
| Tomato | 13 - 22 | 10 | Continuous |

*From Wills *et al*. (1998). Postharvest. 4$^{th}$ Edition. P. 209.

The most commonly know use of ethylene is to trigger ripening is some crops, such as bananas and avocados. The application of ethylene at a controlled rate means that these products can be presented to the customer as "ready to eat". For avocados this is a significant benefit as the consumer can now purchase an avocado to eat that night rather than buying a hard fruit that may take several days to ripen.

The concentration of ethylene required for the ripening of different products varies. The concentration applied is within the range of 1 and 100 ppm. The time and temperature of treatment also influences the rate of ripening with fruit being ripened at temperatures between 15 to 21 $^{o}$C and relative humidity of 85 – 90 %.

Although controlled ripening is the major postharvest use of ethylene it can also be applied pre-harvest to promote postharvest benefits. The chemical Ethephon produces ethylene and is applied in the field. Ethephon can promote several benefits such as fruit thinning (apples, cherries), fruit loosening prior to harvest (nuts), colour development (apples), degreening (citrus), flower induction (pineapples) and it can stimulate lateral branching in potted plants (azaleas and geraniums). All these responses are the result of the plant being exposed to fairly low concentrations of the plant growth regulator ethylene.

**Damaging Effect**

The presence of ethylene is not always beneficial, especially in terms of postharvest shelf life (Optimal Fresh, 2000). It seems that because it is a colourless gas that is not often measured in commercial situations its presence is over looked. A recent survey that included the wholesale markets, distribution centres and retail stores around Sydney showed that the concentration of ethylene present during the marketing of fresh produce was between 0.017 and 0.06 ppm. The main sources of ethylene during marketing and retail sale are from other ripening fruit in the market or storage room or from the exhaust gases of vehicles and forklift trucks. The levels reported had the potential to cause a 10 – 30% loss in shelf life of fresh produce (Wills *et al*., 2000). The effect of ethylene is accumulative so continuous exposure to a low concentration of ethylene throughout marketing can cause significant harm (Wills *et al*., 2000).

However, the loss of shelf life will be most frustrating for the final consumer as the loss of quality will not be obvious during marketing and retail sale.

The major reason for the loss of shelf life is that ethylene exposure increases the rate the product ages. In green tissue such leafy vegetables and cucumbers ethylene stimulates the loss of chlorophyll or green colour and also increases the susceptibility of the product to rots. For maximum shelf life and quality green leafy vegetables should not be stored or transported in trucks where there are mixed loads containing ripening fruit such as apples, pears, mangoes, tomatoes or bananas (Optimal Fresh, 2001).

Lettuce is also susceptible to ethylene. It suffers from a distinctive disorder, called russet spotting as a result of exposure to ethylene. The symptoms of russet spotting are dark brown spotting of the mid-ribs of lettuce leaves. The quality of carrots can also be reduced as a result of ethylene exposure. In response to ethylene, carrots produce bitter tasting compounds called isocoumarins. It has been shown that concentrations of ethylene as low as 0.5 ppm can cause bitterness in carrots within 2 weeks of storage (Reid, 1992). Ethylene can also promote sprouting of potatoes and toughening of asparagus.

A very obvious effect of ethylene is the loss of flowers or leaves from sensitive ornamental plants. Some common flowers that are ethylene sensitive include carnations, delphiniums, freesia, gypsophila and Geraldton wax. Sensitive plants should be treated with an ethylene inhibitor, such as silver thiosulfate or EthylBloc® to prevent flower drop resulting from ethylene exposure and great care should be taken to avoid storage with ethylene producing produce.

**Reducing the Damaging Effects**

Preventing ethylene buildup around the product is often the simplest method of reducing the damaging effects of ethylene. For example products that are sensitive to ethylene are better handled with electric forklifts rather then gas powered ones. Trucks and forklifts should not be left idling in enclosed spaces or during loading or unloading of products. It is also important to remove over ripe or rotting fruit from the storage and handling area, as they are also sources of ethylene. For ethylene sensitive products it is important to avoid storing them with products that produce high levels of ethylene (Optimal Fresh, 2001). Increasing the ventilation rate of the storage area, assuming that the outside air is ethylene free is another way of reducing the level of ethylene around fresh produce.

Ethylene can also be removed by using a number of chemical processes. The traditional method had been to use potassium permanganate or Purafil. Potassium permanganate reacts with ethylene to produce carbon dioxide and water. In order to scrub the air efficiently it is best to spread the potassium permanganate over as larger a surface area as possible either in trays or within highly permeable bags.

For cut flowers it is possible to pulse the stems with a solution of silver thiosulfate. The flowers take the solution up through their stems and this protects them from the effects of ethylene. There is another relatively new compound called EthylBloc® that is distributed in Australia by Rohm and Hass. EthylBloc® is a gaseous compound that inhibits the effects of ethylene. It is effective at very low concentrations, as low as 10 parts per billion (ppb). The active ingredient is 1-MCP (1-methylcyclopropene). Recently there was an article in Good fruit and Vegetables (10:12), May 2000 reporting the potential benefit of using 1-MCP on bananas to prevent premature ripening. EthylBloc® can be used for treatment of flowers but is currently not registered for use on food crops, however registration is in progress.

Ethylene is a very important plant hormone and it plays a significant role in the postharvest life of fresh produce. Sometimes being positive and sometimes not. The damage resulting from ethylene exposure could easily be minimised if there was a greater awareness of the potential harm and the simple measures that can be used to prevent damage.

**References**

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