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ASSESSMENT OF CHEMICALS AND GROWTH REGULATORS ON FRUIT RIPENING AND QUALITY: A REVIEW

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Abstract

Recently ethylene research have offered more rational basis for explaining some of the effects of exogenously applied chemicals and growth regulators. Thus ethephon promotes ripening and increases ethylene in tissues which advance normal ripening processes and may affect storage quality and as delay harvesting. Agriculture ministry has elucidated that the fruits subjected to ethylene gas in low concentration exogenously prompts ripening and are safe in the concentration ranging from 0.001-0.01%. Exogenous application of chemicals including growth regulators significantly decrease post-harvest disease incidence leading to increase in post- harvest fruit quality and shelf life. Among these chemical substances, the ethrel has been found to give promising results. It is manifested that application of chemicals to harvested fruits may often produce very various effects in the stored crop to those observed when similar compound is applied to the fruiting tree. It is reviewed and compiled from collected literature that ripening substances affects traits.

Key words: Fruit quality; ethylene; physical characters; ripening

Introduction

From the scientific point of view, fruit ripening activity is seen as a course in which the physiology and biochemistry are developmentally distorted to influence the appearance, texture, aroma, and flavor (Giovannoni, 2004) It was explained that ethylene, a plant growth hormone which controls several aspects of fruit development, cell metabolism along with initiation of ripening cum senescence, mainly in climacteric fruits. The Ethrel (2-chloroethyl phosphonic acid) decomposes itself and result into ethylene and this has been proved to achieve the ripening of fruits. Such released (Ethylene from ethrel) was more effective in causing fruit ripening than dipping fruits in solution of ethrel chemical (Prasanna *et al.*, 2007). Depending on concentration of ethrel, ripening was 2-6 days earlier, immersed in aqueous solutions of ethrel and 6-9 days earlier in fruits treated with ethylene (released from ethrel), compared with controlled fruits (Nour and Goukh, 2010). Several changes take place as fruits mature and these may be considered as maturity index. They include alteration in carbohydrate composition, resulting in building up of sugar and increased sweetness, colour change, softening of flesh and change of texture and formation of materials containing aroma volatiles.

Changes During Ripening

A. Physical Changes

Fruit colour

The effect of ethrel 500 ppm was accessed for 3 minutes on banana. It was recorded that ripening of banana colour index showed more yellow with green colour at the end of the fruits shelf life (Abd EL-Nobyy, 2010). The ethylene effect regarding its time of exposure on the ripening and quality of ripe banana was studied. It was observed that bananas exposed to ethylene treatment were less green colored than those not treated with ethylene. Bananas exposed to ethylene treatment for one and two days showed significantly reduced green colour

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values than those, which were subjected to ethylene for four days (Ahmad *et al.*, 2006a) The effect of exposure of green matured banana was recorded toward ethylene at 100 ppm and established that, bananas ripened with ethylene treatment were considerably less green than un-treated ones (Mahajan *et al.*, 2019). The ripening behavior of green, unripe banana was accessed by treating with 100 ppm ethylene. It was established that ethylene treated fruits generated a nice yellow colour (Pesis *et al.*, 2005) The mango fruits cv. Neelum treated with ethrel had substantial effect and persuaded early development of yellow colour of fruit (Kulkarni *et al.*, 2004) It was explained in guava fruits cv. Beaumont fruit by treating with 100 µl l^{-1} ethylene that a noteworthy increase occurred in the rate of skin colour (yellowness) (Reyes & Paull, 1995). Fruits dipped in aqueous solution of ethrel @250, 500 and 1000 ppm and reached full yellow colour stage 3, 4 and 6 days earlier than the controlled fruits (Ibtissam, 2010) It was discovered that fruit peel color score was regularly increased and ethrel treatments enhanced color development in fruits. Dipping fruits in ethrel @ 250, 500 and 1000 ppm attained final yellow stage 3, 4 and 6 days earlier. Ethrel and ethylene applications improved color development in white-and pink-fleshed fruits (Nour and Goukh, 2010). Ethephon was applied in winter guava cultivar Sardar fruits under Punjab conditions and finalized that colour development was enhanced by ethephon chemicals @ 300, 400 and 500 ppm (Gill & Bal, 2010) Various experiments were conducted to improve ripening quality of fruits (winter season). Colour development was improved by applications of ethephon @ 300, 400 and 500 ppm (Gill, 2013) The colour of rainy season fruits cv. Allahabad Safeda was reported to enhance in colour with ethephon @ 500 and 1000 ppm applications *i.e.* yellow green (Y 144 C) and yellow (Y 12 C) (Brar *et al.*, 2012). To assess the effect of ethrel on fruits different research experiments were carried out and it was discovered that ethrel treatment considerably improved skin colour advancement in fruits (Mohamed *et al.*, 2016). It was proved in Allahabad Safeda' *(Psidium guajava* L.) fruits that a-value-redness, L, a, b parameters (L-value-lightness, and blueness and greenness and b-value-yellowness) were significantly affected by the temperature and time of the blanching procedure. The standardized lightness L (n) values were superior to that of the control (Parimita *et al.*, 2016). Maleic hydrazide postponed colour development in peel of both white and pink fleshed fruits type. Fruits treated with Maleic hydrazide @ 250, 5000 and 1000 ppm, attained the full yellow colour stage as compare to the controlled fruits (Ibtissam, 2010). Bal *et al.* (1996) reported the technique to induce early and uniform ripening permit staggering the harvest in Umran ber. This practice avoids the bothersome operation of picking ber in 4-5 lots. Ethephon at 400 ppm at colour break stage in the first week of March advanced ripening by two weeks and produce attractive, uniform, better quality and deep golden yellow with chocolate tinged coloured ber fruits. Ethephon at 400 ppm improved the fruit colour to golden yellow along with the highest TSS content for cultivar Umran fruits (Masalkar and Wavhal, 1991). Exogenously application of ethylene (100 µl·liter-1) stimulated the rate of ripening in papaya fruit by skin yellowing and increases flesh softening (An and Robert, 1990). Uniform yellow colour advancement in mango by dipping in ethrel solution after harvest is also reported but there was no definite trend in the change of 'L' values (Tandon and Kalra,1995).

Fruit firmness

The firmness of orange fruits decreased during ripening period in all treatments when the fruits were subjected to ethylene gas (150 ppm) and various concentrations of ethephon (250, 500, 750, 1000 ppm) each for 5 minutes while untreated control fruits were tough and remained unripe, while ethephon (1000 ppm) treated fruits were least firm. Fruits treated with ethylene gas (100 ppm) and ethephon (500 ppm) registered sufficient firmness (Chauhan *et al.*, 2012). The treatment with ethylene 100 ppm resulted in declining of firmness in Patharnakh pears as compared to control fruits (Dhillon and Mahajan, 2011). When mangoes cv. Ataulfo treated with 100ppm ethylene, had an apparent effect on firmness. Firmness was lower in ethylene treated mango fruits, but variations were clearer in control with highest firmness (Montalvo, 2007). When Tron and Hoi mango fruits were dipped in ethrel and water as control treatment, the flesh firmness of Hoi mango was maintained higher and longer as compared to Tron mango, but was decreased more at higher concentration of ethrel. This pointed out important role of ethylene on texture alteration in mango (Hai *et al.*, 2009). It was revealed in banana that the ethylene (100 ppm) treatment showed lower firmness compared to control (Saeed *et al.*, 2006). Ripening was initiated by exposure to exogenous ethylene for 24 hrs in a closed chamber and the firmness of the fruit decreased within 2 days (Sane, 2005). Firmness in banana cv Grand naine treated with ethylene gas and ethephon (250, 500, 750, 1000ppm) declined during ripening period. Untreated control fruits were hard and remained unripe; while ethephon (1000 ppm) treated fruits were least firm (Mahajan *et al.*, 2010). It was established that ethephon @1800 ppm caused better firmness and advanced organoleptic quality in fruits (Singh *et al.*, 1996). Fruits treated with ethrel treatment in aqueous solution had attained the soft stage 2-6 days earlier, while those treated with ethylene had attained final soft stage 6-9 days prior, compared to the controlled ones (Ibtissam, 2010). It was reported that firmness had exhibited a continuous decline during ripening method with ethrel. The decline in firmness was recorded in untreated guava fruits were about 15-folds, from the hard mature-green stage to soft ripe stage (Nour and Goukh, 2010). Ethrel treatment caused decrease in firmness in both seasons under Sudan conditions (Mohamed *et al.*, 2016). It was reported that application of chlorflurenol methyl ester 74050 (Chlorflurecol) @ 10-1000 ppm in fruits crop cv. Allahabad Safeda caused prevention of loss in fruits firmness. Losses of non-volatile organic acids and sugars were decreased in the treated fruits (Nour, 2015). During ripening process, white and pink fruits showed a constant decline in firmness. Fruits treated with Malic Hydrazide @ 250, 500 and 1000 ppm without waxing treatment, reached the final soft stage in two, four and six days respectively, compared to controlled fruits in fruits (Nour and Goukh, 2010). It showed in fruits that fruit ripening was greatly improved with ethrel chemical. Fruit development rate regularly improved with the increase in concentration. Ethylene released from ethrel was effective in ripening of the fruit than dipping technique in ethrel. This effect on fruit ripening was précised by increased climacteric peak of respiration increased TSS along with declined flesh firmness (Nour, 2015). Excessive flesh softening occurred within 3 days of exposure of watermelon fruits to 5 ml l_1 C_2H_4 at 18°C (Risse and Hatton, 1982). Treatment with ethylene gas (100 ppm) resulted in adequate ripening of tomato fruits with uniform red colour, advantageous firmness, least rotting and acceptable quality (Dhall and Singh, 2013). Texture of Mango fruits decreased at faster rate with increase in ethrel concentration. The decrease could be due to breakdown of insoluble protopectin into soluble pectin content or by cellular disintegration caused membrane permeability (Brinston *et al*. 1988).

Palatability rating

Ethrel treated fruits exhibited optimum ripening on 8th day of storage with best sensory qualities in mango cv. Neelum (Nour and Goukh, 2010). All the treatments of ethrel application improved the taste of mango cv Kensington as compared to untreated fruits (Nair and Singh, 2003). It was established in the banana cv. Grand naine that treatment with ethylene gas (100 ppm) resulted in 7.8 score on 4th day and were rated as very much desirable and closely followed by ethephon 500 ppm (Mahajan *et al.*, 2010). Highest palatability rating of guava fruits cv. L-49 was achieved with ethrel @1000 ppm (Yadav *et al.*, 2001). Fruits trees cv. Sardar were sprayed at PAU, Ludhiana with ethephon (300, 400 and 500 ppm) and observed that palatability rating was improved by ethephon applications along with total sugars, TSS, and vitamin C (Gill, & Bal, 2010). It was concluded that ethephon @ 300, 400 and 500 ppm in winter guava cv Sardar was greatly improved palatability rating in fruits (Gill *et al.*, 2010). Ethephon @ 1000 ppm resulted in maximum palatability in fruits cv. Allahabad Safeda and followed by application of ethephon @ 500 ppm while palatability rating was lowest in untreated fruits (Brar *et al.*, 2012). Under Sudan conditions ethrel treatment resulted in an increase in taste of fruits (Mohamed *et al.*, 2016). Mango fruits Cv. Kesar ripened by ethephon dip treatment of 750 ppm for 5 minutes and stored at ambient condition showed better results regarding acceptability score (Kad *et al.*, 2017).

Physiological loss in weight

The effect of ethylene on PLW of orange fruits was evaluated and fruits were exposed to ethylene gas (150 ppm) in ripening chamber. It was reported that the highest PLW in ethephon 1000 ppm during ripening period of 28 days which was trailed by ethephon 750 ppm. These treatments resulted in shriveling, softening and over ripening of orange fruits. Ethylene gas (100 ppm) and ethephon (500 ppm) resulted in adequate ripening and softening of oranges. Lowest physiological loss in weight was observed in control fruits with green and hard texture (Chauhan *et al.*, 2012). Mature green mango cv. Manila fruits treated with ethylene exhibited more loss in physiological weight of fruit than control (Lagunes *et al.*, 2007). The effect of ethylene exposure in green mature banana cv. Grand Naine fruits was recorded and fruits were treated with ethephon (250, 500, 750, 1000 ppm) each for 5 minutes. The highest physiological loss in weight was recorded with ethephon 1000 ppm, which was followed by ethephon 750 ppm (Singh *et al.*, 1996). Weight loss was recorded more in ethylene applied banana fruits. Notably high physiological loss in weight was observed per day of storage, whereas it was in control treatment (Saeed *et al.*, 2006). At GBPUA & T, Pantnagar the fruits of guava cv. Sardar were sprayed with ethephon and stored at ambient conditions. Lowest weight loss of fruits was noted with ethephon application @400 ppm. It was recognized that advanced concentration of ethephon resulted in high weight loss in fruits (Singh *et al.*, 2012). The effect of ethephon on fruits *var.* Allahabad Safeda was studied at PAU, Ludhiana. Hard green, uniform fruits of fruits were dipped in ethrel for 4-5 minutes then stored under ambient conditions. Ethephon @500 ppm resulted into least weight loss of the fruits fruit and was closely followed by ethephon@1000 ppm (Mahajan *et al.*, 2004). The effect of growth retardants, chemicals and various coatings (coconut oil and liquid paraffin) on fruits was evaluated at FRS, Jabalpur. They detailed that weight loss at various intervals was much less with application of MH @250, 500, and 750 ppm. But such loss increased after 12 days of storage where MH-750 ppm was used (Pandey *et al.*, 2010). Hot water application and storage displayed maximum value of weight loss at Cairo University in Mamoura fruits (Ismail Omayma *el al.*, 2010). Higher ethylene concentration advanced the physiological process such as transpiration, respiration which resulted into additional physiological loss in weight due to moisture loss. Similar conclusions were also described by Dhemre (2001), Dhemre *et al.,* (2005), Lagunes *et al.,* (2007), Dhillon and Mahajan (2011), Daware (2012), Venkatram and Pandiarajan (2014) in mango fruits.

Fruit spoilage

Ethephon @1000 ppm resulted into minimum fruit spoilage and was closely followed by ethephon @ 500 ppm in 4- 6 days of storage while fruit spoilage within 2 days of storage (Mahajan *et al.*, 2004). Hot water treatment to guava provided a longer storage life than control, as occurrence of rotting of fruits were about 6-8% for the control fruits stored under storage conditions (Pandey *et al.*, 2010). Chlorflurenol methyl ester 74050 (chlorflurecol) @ 10-1000 ppm applied to fruits fruit cv. Allahabad Safeda and resulted into avoidance of fungal decompose of the fruit. Higher concentrations of the morphactin>200 ppm, offended the soft skin of the fruits. Morphactin at 100 ppm was the most suitable concentration for retaining the market value of the fruits by checking various detrimental physiological, textural and biochemical processes (Gupta *et al.*, 1980).

B. Bio-chemical Changes

Total soluble solids

Mangoes fruits cv. Alphonso treated with ethrel (750 ppm) and stored at ambient conditions, induce early and uniform ripening with higher TSS compare to control (Das *et al.*, 2011). Orange fruits were treated with ethephon (250, 500, 750, 1000 ppm) and it was noticed that the TSS content of oranges was the highest with ethephon 1000 ppm and lowest in control fruits (Chauhan *et al.*, 2012). The effect of ethephon (500 ppm, 1000 ppm and 1500 ppm) and ethylene (100 ppm) on TSS % was accessed in pear and recorded an important increase in TSS under all treatments up to 8th day and declined thereafter. Maximum TSS was recognized under fogging ethephon 100 ppm and 1500 ppm, trailed by ethepon 1000 ppm (Dhillon and Mahajan, 2011). It was discovered that mango cv. Himsagar when subjected to ethrel (250, 500 and 1000 ppm) showed an increase in TSS. During the storage, total soluble content (TSS) inclined up to 9th day with various treatments (Siddiqui and Dhua, 2009). Ethylene was applied in mature green mango cv. Keith and recorded an increase in TSS for both treated and control mango fruits. Treated mangoes were found higher in TSS as compared to control (William and Ellis, 2009). Fruits cv. L-49' were sprayed 30 days after fruit set in both rainy and spring seasons with ethrel @ 0.125 or 0.250 ml/liter and found higher TSS content in both seasons. Gill *et al.,* (2010) proved while working in winter season Sardar fruits that highest TSS could be obtained with ethephon @ 400 ppm (Biswas *et al.*, 1988). It was revealed at Rajasthan that highest TSS could be recorded in 500 ppm ethrel treatment in guava fruits cv. Sardar (Jain & Dashora, 2010). Highest TSS was recorded in winter fruits cv. Allahabad Safeda with ethephon @1000 ppm followed by 500 ppm ethephon (Brar *et al.*, 2012). The fruits collected from controlled plants exhibited lowest TSS. Highest TSS with 0.2 % boron + ethrel 1000 ppm was recorded which was at par with the 0.2 % boron + ethrel @ 750 ppm and 0.2 % boron + ethrel 500 ppm(Rajput *et al.*, 2015). Mohamed *et al.,* (2016) accomplished while applying ethrel to mature-green fruits of fruits guava and observed that ethrel treatment accelerated total soluble solids (TSS). At Jorhat, ethrel application @ 50 and 100 ppm to Allahabad Safeda guava resulted in enrichment of TSS (Lal *et al.*, 2017). It was proved in guava fruits at Bhagalpur that total soluble solids were improved as compared to controlled fruits with application of MH @500 ppm and 1000 ppm but insignificantly (Brahmachari *et al.*, 1997). MH treated fruits at 250, 500 and 1000 ppm without waxing process obtained highest TSS value, two, four and six days later compared to untreated fruits, respectively (Nour, 1997). It was revealed in Allahabad safeda' *(Psidium guajava* L.) that there was important difference in Total soluble solids contents (TSS) at dissimilar intervals (Parimita *et al.*, 2016). Increase in blanching extent caused increase in TSS of grape fruit; this occurred due to water loss during heating course, concentration of the solute was improved and this ultimately reflected increase in TSS (Purvis, 1983). It might be possible that the degradation of pectin and cellulose content released soluble materials which raised TSS of citrus fruits (Echeveirra,1988).

Acidity

Acidity value in the orange fruits treated with ethylene 150 ppm and ethephon (250, 500, 750, 1000 ppm) showed the narrow range in different treatments (Chauhan *et al.*, 2012). The effect of ethephon (500 ppm, 1000 ppm and 1500ppm) and ethylene gas (100 ppm) was observed on acidity in pear and recorded that acidity content in pear declined and inclined afterwards. Lowest acidity content was recorded in 1000 ppm ethephon, while acidity was highest in control fruits at ambient temperature in storage (Dhillon and Mahajan, 2011). The effectiveness of ethrel of 500 ppm in banana was recorded that titratable acidity with ethrel was high as compared to controlled fruits (Abd EL-Nobyy, 2010). Ethrel was applied 500, 750 ppm and 1000 ppm in the mango cv. Amrapali and minimum acidity was recorded with ethrel (750 ppm) on 10th day of storage (Singh *et al.*, 2012). It was established that there were no important effects of ethrel on the acidity (Gupta and Mukherjee, 1980). Ethephon spray affected the acidity of guava fruits and acidity content was decreased by higher dose of ethephon during both rainy and winter season crops of fruits cv. Sardar (Suleman *et al.*, 2006). At Junagadh Agricultural University it was concluded that fruit acidity in L-49 guava fruits were higher in mixture of treatment Boron@ 0.2% and Ethrel @ 500/750 ppm (Rajput, 2008). It was recorded that acidity in Allahabad Safeda was the maximum, kept at control in both rainy and winter season crops (Brar *et al.*, 2012). The plants sprayed with ethephon @1000 ppm in winter season showed minimum acid content. In guava fruits cv. Allahabad Safeda at Assam Agricultural University ethrel treatment @ 50 and 100 ppm reduced the titrable acidity (%) of the fruit. They detailed that both doses of tried ethrel were useful in lowering the acidity of guava fruits (Lal & Das, 2017). Experiment conducted in grapes at PAU, Ludhiana revealed that the quality of fruits was better with respect to total soluble solids (TSS), acidity, sugars and anthocyanin content in 75 % crop load + Ethephon 400 ppm (Kumar *et al.*, 2017).

Vitamin C

Dipping of mangoes cv. Alphonso that dipping of ethrel (750 ppm) for ambient storage resulted in early ripening as compared to control and ascorbic acid content was improved (Das *et al.*, 2011). Research studies carried out in fruits cv. L-49 at FRS, Junagadh revealed that foliar application/spray of Boron + Ethrel caused evident increase of vitamin C (Rajput, 2008). Influence of ethephon in winter season guava cv Sardar fruits at KVK, Hoshiarpur revealed that there was enhancement of vitamin C with ethephon @ 400 ppm (Gill & Bal, 2010). Ethephon treatment enhanced the vitamin C in fruits cv. Allahabad Safeda. Maximum vitamin C was recorded in fruits obtained from trees with ethephon @1000 ppm and followed by ethephon @500 ppm application (Brar *et al.*, 2012) Ethrel treatment @ 50 and 100 ppm enhanced ascorbic acid (mg/100g) of Allahabad Safeda guava at Jorhat. Both applied doses of ethrel (50 ppm and 100 ppm) were effective in improving ascorbic acid of fruits (Lal & Das, 2017). Ascorbic acid and polyphenol etc. contents were considerably inclined by the hot-water treatment. Fruit quality was found to be much better (Kor, 1997). It was proved in guava fruits cv. Allahabad Safeda at U.P. that there were differences among vitamin C of fruits cubes, blanched at 80°C temperature. Loss of vitamin C was observed in different treatments in comparison to control (Parimita *et al.*, 2016). Ethephon is responsible for the immediate ripening and enhancement of ber fruit quality. [58, 64, 77–79]. Ethephon treatment at 500 mg/L improved ascorbic acid in jujube fruit, whereas titratable acidity was reduced (Abbas *et al.*, 1994). Pre-harvest spraying of ethephon resulted in increased the TSS and vitamin C and decreased acidity in ber cv umran culti*var.* (Chauhan and Gupta, 1985; Sandhu *et al.*, 1989). Ethylene treated papaya exhibited poor fruit quality when compared to that of fruit allowed to ripe naturally ripened papaya fruit (Fabi *et al.*, 2007). Ethylene in the storage conditions decreased the quality of pears (Veltman *et al.*, 2002).

Total sugar

Ethrel @ 0.125b or 0.250 ml/liter under both spring and rainy season conditions caused higher sugar in guava fruits (Biswas *et al*, 1988). Ethrel was applied @ 50, 75 and 100 ppm, to fruits and reported that total sugars had improved in guava cv. L-49 fruit (Yadav *et al*, 2001). Various experiments were conducted in guava fruits cv. L-49 at Junagadh Agricultural University and recorded obvious increase in total sugar of fruits (Rajput *et al.*, 2008). At Udaipur (Rajasthan) ethrel @ 500 ppm treatment resulted in maximum total sugar (non-reducing sugars, and reducing sugars), in guava fruits cv. Sardar (Jain& Dashora, 2010). Highest total sugars were recorded in 0.2 % boron + ethrel 1000 ppm, which was at par with 0.2 % boron + ethrel 500, 750 ppm and 0.2 % (Rajput *et al*, 2015). The effect of KNO_3 and ethephon in Sardar fruits was studied under Punjab conditions and maximum TSS was recorded with ethephon @ 400 ppm (Gill & Bal, 2010). Under Assam conditions in Allahabad Safeda ethrel application @ 50 and 100 ppm improved total sugar (%) content of the fruit (Lal & Das, 2017). Application of Chlorflurenol methyl ester 74050 (chlorflurecol) @ 10-1000 ppm in fruits cv. Allahabad Safeda caused prevention of loss in firmness. Non-volatile organic acids along with sugars were also declined in the treated fruits (Gupta and Mukherjee, 1980). It was described at Bihar Agricultural College that different quality characters like total sugar and reducing sugars of fruits enhanced (non-significantly) as compared to control when MH @500 ppm and 1000 ppm was applied (Brahmachari *et al., 1997)*. Total sugars (including reducing sugars and non-reducing sugars) were noticeably influenced by the hot-water treatments. Resultant ber and pomegranate fruits were much better in quality (Kor, 1997). Noteworthy variations were observed among reducing sugars of different hot water treatments in Allahabad Safeda fruits at U.P area and these results turned down in comparison with control (Parimita *et al.*, 2016). This might be occurred because during heat treatment reducing sugar lessened due to caramalization (Sheryl, 2004). Ethrel @ 50, 75 and 100 ppm influenced the guava fruits cv. L-49 and yielded better total sugars (Yadav *et al.*, 2001). It was discovered at Mizoram University that ethrel application @ 400 ppm caused development of sugars and it might be due to the quick ripening behavior and speed up actions of hydrolytic enzymes, which was connected with high metabolic modification in fruits, leading to the alterations of complex polysaccharides and organic acids into simple sugars through advanced respiration and carbon assimilation events in fruits (Yadav *et al.*, 2001). Similar results are detailed by other research scholars (Biswas *et al.*, 1988).

Conclusion

During marketing of fruits, ripening and quality is an important parameter. It can be fastened with help of various substances. Ethylene gas causes a change in softening and color change of the fruit. Moreover, ethylene gas not only manipulates fruit ripening process but also causes death of the plants. Other effects of ethylene are abortion of plant foliage and stems, loss of chlorophyll, shortening /bending of the stems. During the last decade, the accomplishment of highly developed high-throughput technologies in metabolomics, genomics and proteomics threw new lights on the procedures by which ethylene controls the ripening process.

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