

Effect of 2-Chloroethyl Phosphonic Acid (Ethrel) on Ripening of Summer Tomato



A Thesis

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Submitted by

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**Examination Roll No: MS-070732
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Khulna-9208, Bangladesh
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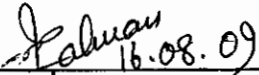
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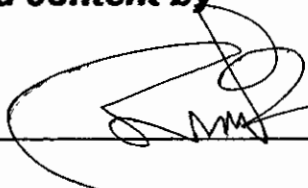
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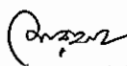
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DECLARATION

This thesis is the original research of the author, except or otherwise stated. The material presented in this report has not been submitted either in whole or in part for a Master Course from this or other university. The findings of the research has not been/will not be published anywhere without the concerned course supervisor or co-supervisor of the programme.

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DEDICATED TO-

MY BELOVED

PARENTS

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Abstract

The Study was conducted at Horticulture Research Centre, Regional Agriculture Research station (RARS), Bangladesh Agricultural Research Institute (BARI), Jessore, Bangladesh. The Experiment was conducted to clarify the effect of ethrel on ripening of summer tomato and also clarify the stage which was beneficial for us. Main constituent of Ethrel is Ethepone 48 S.L (2-chloroethyl phosphonic Acid) was obtained formulated as the commercially available 100% pure (Sigma Company Limited). Ethrel extends tomato fruit cell division and increase fruit size and yield. Water and ethrel treatments were used at 20th days after fruit set and 30-35th days (full ripening). Ethrel-induced ripening of immature and mature-green fruits including summer tomato. The best concentrations and time of application used were 100 ppm for 5 minutes. The best result was observed in case of days to ripening (2.67days), TSS (4.33), Skin color (10.00), shelf life (14.67 days) and taste (good) when mature fruits of Bari Hybrid-4 and Bari Hybrid-5 were treated with ethrel than immature fruits treated with ethrel as well as water. Ethrel was used as a management tool to aid maturity and color development in fruit. It was also used in synchronizing uniform ripening for once-over harvest and to enhance ripening in late varieties or during late seasons or when ripening was delayed. It can modulate plant growth and metabolism by releasing ethylene from tissues even the harvested fruits.

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LIST OF ABBREVIATIONS

ACC (1-aminocyclopropane-1-carboxylic acid)

AOA (aminooxyacetic acid)

CD (cell division)

CE (cell elongation)

CV (Co-efficient Factor)

C₂H₄ (Ethylene)

DMRT (Duncan's New Multiple Range Test)

Etc (Evapotranspiration)

Ethrel (2-chloroethyl phosphonic acid)

LSD (Least Significant Difference)

MW (Molecular weight)

ppm (Parts per million)

TSS (Total Soluble Solids)

Chapter One
Introduction

CHAPTER ONE

Introduction

Tomato, member of Solanaceae family and is a very popular consumable vegetable crop in Bangladesh. It is consumed freshly as salad and culinary purposes. There is a high potential of export value of processed products form tomato. Sauce, ketchup, jam, jelly, pickles and others ready to serve foods for the millennium people can be processed form tomato. It ranks high for its nutritive value. It is a good source of vitamin A, B, C and calcium, iron etc (Mohiuddin *et al.*, 2007). According to Mohiuddin *et al.*, (2007) nutritive elements almost double compared to apple. It has wonderful medicinal value too. Consumption of tomato is believed to benefit the heart diseases. Lycopene, one of the most powerful natural antioxidants, prevents prostate cancer (Bhutani and Kallo, 1983), reduces blood pressure and improves ability of skin to protect against harmful UV rays. Its popularity, area under cultivation and demand is increasing all over the country day by day.

In Bangladesh naturally tomato grows in winter season. Currently there are many varieties of summer tomato also. After ripening it takes limited time to get rotten (within one week), which is a great loss in agriculture. To improve color of tomato, farmers use harmful chemical like Calcium carbide on mature and immature fruits or vegetables to ripe, which causes different harmful effect on both human and animals. Because most of the farmers of our country are illiterate they do not know the effect of these harmful chemicals to human and animals' health. Now Agricultural Research Institutes and other organizations are searching the way of agricultural improvement that they can help the farmers to improve their economical condition and also teach them about the chemicals they usually use to improve their productivity and ensure the quality of crops.

Researchers also searching the chemicals for maintaining the quality of vegetables and which are harmless to human, plants and animals and also Improve our economic condition. Now Bangladesh Agricultural Research Institute use different hormone or growth regulator such as ethylene, ethrel for ripening different fruits.

Ethylene, as a plant hormone, is produced by many fruits even during their early stages of growth and development (Atta- Aly, 1988, Burg and Burg, 1965). It was thought that this early production of ethylene is responsible for young fruit abscission until (Maxie and Crane, 1968) revealed that the increased level of ethylene produced by young fig fruit was the reason behind early fruit growth. It was then believed that ethylene may have major and significant roles in fruit development during its ontogeny. The increased levels of ethylene production in the early stages of development was observed in many fruit species including tomato (Abdel and Rahman, 1977, Atta-Aly, 1988, Elsadig and Beltagy et al., 1976), sycamore fig (Maxi and Crane, 1968), peach (Looney et al., 1974) apple and cherry (Blanpied, 1972). In tomato, the early peak of endogenous ethylene occurred during the very early stage of fruit development was shortly followed by a gradual decrease, reaching a stable low level until ripening onset when another increase was observed with the beginning of climacteric rise (Abdel-Rahman, 1977, Atta-Aly, 1988, Elsadig and Beltagy et al., 1996). Same trend was also found regarding tomato fruit content of ACC (1-aminocyclopropane-1-carboxylic acid) (Atta-Aly, 1988) as an immediate ethylene precursor (Adams and Yang, 1979).

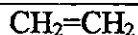


Fig.1. Chemical formula of ethylene.

Ethrel (2-chloroethyl phosphonic acid) is a chemical that can apply to plant tissue to accelerate the production of ethylene (plant hormone) which accelerates senescence and/or fruit ripening (Telewski and Mordecai, 1986) Ethrel extends tomato fruit cell division and increase fruit size and yield. H₂O and ethrel treatments during the first 4 weeks after anthesis was reversed to an ascending order 35 days after anthesis until fruit reached red-ripe stage. Ethrel-induced ripening of immature and mature-green fruits including tomato. The best concentrations and time of application used were 1000 ppm for 5 minutes.

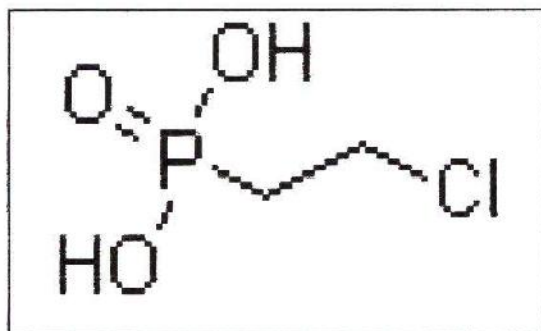


Fig .2. Chemical structure of ethrel.



Fig .3. Tomoto fruits before and after using of ethrel.

The study was undertaken to clarify the following objectives:

- to clarify the effect of ethrel on ripening of both mature and immature summer tomato.
- to identify the response of ethrel in fruit color, shelf life.
- to study the increase of fruit quality(especially total soluble sugar)
- to identify the stage which is less harmful for human and plants.

Chapter Two
Literature review

CHAPTR TWO

Review of Literature

2. Physiology of Tomato

According to the histological studies, the transection of tomato fruit during its early stages of growth and development showed that fruit pericarp tissues consisted of exo and mesocarp tissues. Exocarp tissue is formed from uniecuete parenchymatous cells coated with cuticle with 2-3 layers of cells located under the epidermis called hypodermis. Mesocarp tissue, on the other hand, was formed from 2 different layers defined as outer and inner mesocarp layers. The outer mesocarp layer is located in the distance between the hypoderms and the vascular bundle of pericarp tissues while the inner mesocarp tissue is entirely paranchymatous cells local tissue is entirely paranchymatous cells located under the vascular bundle and extended to reach the loci of the ovules. It was also noticed that the transition phase from CD (cell division) to CE (cell elongation) is mostly happened in the outer and inner mesocarp layers.

A tomato flower has both male (stamens) and female (pistil) parts within the same flower. The yellow stamens wrap around the greenish pistil in the center of the flower. Under proper conditions, pollen from stamens transfers to the sticky stigma or tip of the pistil. This transfer requires a jarring wind or a flick of the finger. Without pollination which stimulates fruit set, the flower withers and dies (Linn Mills, Common Tomato Disorders under Desert Conditions FS-88-60)

Tomato is the most commonly-produced greenhouse vegetable crop (Nitsch, 1952). Although claims by greenhouse promoters are made that 30 or more lb marketable fruit can be expected per plant (or plant-space) per year, such production is only possible with very high inputs in quality facilities and optimal cultural practices. Production in western Oregon of 20 to 25 lb/plant space/year would be a more realistic top yield. A one crop schedule (December to December) is used by some Pacific Northwest growers and is common in British Columbia, Canada. Growers there start their crop in January and harvest usually from March through November. A two-crop system is recommended under western Oregon conditions. This would consist of a fall (August to December) and a spring (January to June) crop. A two crop system is at less risk from crop pests and allows fruit set and harvest when environmental conditions are best and competition from outdoor productions is least.

Early to mid season - Santiam, Oregon Spring, Oregon Star, Oregon Pride (all seedless, with the latter two being large-fruited, resembling paste tomatoes), Springset, New Yorker, Fireball, Earli- rouge, Earli- bright, Coldset, Jetfire, Willamette, Pilgrim (early with multiple disease resistance), (Telewski and Mordecai, 1986).

Mid Season to Late - Pik Red, Celebrity, Pik Rite, Castlehy101, Carnival, All Star, Setmore, Supersonic, Royal Flush, Monte Carlo, Better Boy, Carmen, Medford, Milagro, Sunny, Summerset. Research in the Hermiston area indicates that Baja, Keno, Oregon Spring and Valerie performed well Pressman, (Huberman, et. al., 1983).

Mid-winter greenhouse tomato production is not generally recommended for western Oregon. Poor light intensity and high humidity often result in poor fruit set and quality (Kuo, et. al., 1978). Effective lighting and humidity control is not

considered to be economical. Heating and other production and marketing costs, and competition from outdoor production from California, Arizona and Mexico, and the availability of greenhouse tomatoes from Canada at competitive prices, make profitable greenhouse production in western Oregon difficult. Greenhouse production (Metha and Mathi, 1995). In British Columbia is possible because of their high inputs and the technical level of management possible in large operations (the trend is to shift to operations of over 2 acres), and the high quality glass greenhouses being used in the great majority of the operations, and their strong marketing organization.

It is an herbaceous plant with bisexual flowers. It is a self-pollinated crop but in some cases as high as 30% cross-pollination has been reported (Atta-Aly, 1988). The fruit is a true berry. Depending upon the growth habit, the tomato plants have been categorized into two-indeterminate and determinate types. Determinate tomato plants grow like a bush to a certain size (about 3 to 5 feet), set fruit, and then decline. Most of the early ripening tomato varieties are of the determinate type. The vines of indeterminate plants continue to grow until frost or disease kills them. Many of the standard-sized, all-summer tomatoes typical of the home garden are of the indeterminate type. They require support of some kind for best results, since the fruit would otherwise be in contact with the soil and thus susceptible to rot. (UC Davis, Vegetable Research and Information Center- Home Vegetable Gardening).

Successful plant reproduction depends entirely on fruit-set, an essential process that can be defined as the activation of a developmental program which converts the pistil into a developing fruit. This transition comprises two different and coordinated processes, namely the fertilization of the ovule and the growth of the surrounding pistil and/or other structures to allocate the developing seeds

(Gillaspy, et al., 1993). The change-over from the static condition of the flower ovary to the rapidly growing condition of a young is a dramatic shift. This important phenomenon, commonly spoken of as fruit set, is a special step in the life cycle of all sexually reproducing higher plants. Subsequent work has demonstrated that fruit set in general is at least in part a function of auxin in the ovary (Leopold and Scott, 1952).

Fruit set and pollination mainly depend on the sensitivity of temperature. Under high temperatures, morphological changes in the flower structure such as style exsertion out of the antheridial-cone, browning and drying of the stigma (Abdalla and Verkerk, 1968) are observed.

High temperatures induce drop of buds and flowers in the tomato (Leopold and Scott, 1952; Leopold, *et al.*, 1975. Abdalla and Verkerk, 1968). Flower drop is essentially a result of lack of fertilization which, in turn, is affected by a number of factors. Under high temperatures, gametogenesis is disturbed, gamete viability is reduced (Iwahori and Takahashi, 1964; Iwahori, 1965, 1966) and less pollen is produced in the flower (Abdalla and Verkerk, 1968). High temperatures can also affect the germination and the elongation of the pollen tube into the style and thus inhibit fertilization (Iwahori and Takahashi, 1964, Iwahori, 1967). Any of these changes may prevent or reduce self-pollination, resulting in low rates of fruit set.

If the day and night temperature remain cool within the range of 26°C to 12-22°C respectively, the flower initiation set off early and fruit development begins very rapidly (Halder, *et al.*, 2003). High temperatures have been reported to limit tomato production wherever days are warmer than 32 °C, or nights are warmer than 21°C (Moore and Thomas, 1952). Because of this high temperature sensitivity, poor fruit set is an important limitation to tomato production during summer season (Villareal, 1980). At higher temperature, the probability of floral

abscission is high after anthesis (Iwahori, 1967). High light intensity accompanied by high temperature is also harmful to fruit-set. High light intensity affects the internal temperature of the reproductive organ of tomato (Kuo, *et al.*, 1978)

The Chinese may have been the first to observe the effects of ethylene when they noted that burning incense increased fruit ripening. In 1864 leaks in gas lights in street lamps were reported to stunt plant growth and defoliate trees. In 1901, D. Neljubow realized that his dark-grown pea seedlings were short, fat and negatively gravitropic (the triple response) because of a component in "laboratory air" which he subsequently identified as ethylene. Cousins (1910) first reported that ethylene occurred in plants.

2. 1. Physiology of Ethylene:

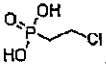
Ethylene is a single compound (like ABA) and is not a family of related ones (*i.e.*, gibberellins). Structure and molecular weight of ethylene are $\text{CH}_2=\text{CH}_2$, (MW 28) which is similar in size/shape as water. It is a gaseous plant hormone (Atta-Aly, *et al.*, 1994).

Ethylene triggers fruit ripening (*i.e.*, climacteric) - Flavr-Savr tomat (Abeles *et al.*, 1992). This is the shedding of plant parts. Occurs at a specialized layer of cells – the abscission layers. Auxin (Nitsch, and Nitsch, 1961) apparently prevents leaf abscission by maintaining cells in the abscission zone insensitive to ethylene. When auxin levels in the leaf decline, the tissues become sensitive to ethylene that promotes abscission by producing and secreting cellulases, etc. Downward bending of leaves - common response to flooding or waterlogged soils. Pea seedlings treated with ethylene are short (inhibits internode elongation), fat (increase stem thickness) and "stupid" (horizontal growth, no positive gravitropism). Further, they show little leaf expansion and possess an apical

hook. The change in growth form in response to a mechanical stimulation such as touch. Stimulates germination in cereals, peanuts; promotes sprouting in potato tubers and other bulbs (Yang, 1980). Ethrel (Ethepon) liquid sprayed onto plants. It contains a dilute solution of 2-chloroethylphosphonic acid that breaks down to give off ethylene. Among others things, it is used to synchronize flowering and fruit set in pineapples. Commercial fruits are usually stored in low O₂ to inhibit ethylene biosynthesis or under high CO₂ to prevent ethylene action as a ripening promote (Abeles, et al., 1992).

2. 2. Physiology of Ethrel

According to Burg SP, Burg EA in 1965 Chemical structure of ethrel is 2-chloroethylphosphonic acid. Other Name: chloroethyl phosphonic acid; Cerone; Bromeflor; Ethrel; Florel; Prep; Arvest; Flordimex; 2-Chloroethanephosphonic acid; (chloroethyl)phosphonate; chlorethephon; ethephon [chloroethephon]. Molecular Formula: C₂H₆ClO₃P, Molecular Weight: 144.49. Structure of

ethrel: . Appearance: White or light yellow crystals, Melting point: 74-77 °C.

EPA II3. Acute oral LD₅₀ for rats' 3030mg a.i. /kg. Acute dermal LD₅₀ for rabbits 1560mg a.i. /kg. Irritating to skin and eyes (Abdulla, A.A. et al, 1968). In a 2 years feeding trial, rats receiving <3000 mg/kg/d diet showed no increase in carcinoma. Acute oral LD₅₀ for bobwhite quail 1000mg/kg. Fish LC₅₀ (96 hr) for bluegill sunfish 300mg/l, rainbow trout 350mg/l, daphnia EC₅₀ (48 hrs) >500 mg/l. Non-toxic to bees and earthworm at normal dosage. Ethepon can modulate plant growth and metabolism by releasing ethylene from root, bloom, fruit, legume and other tissues. It can accelerate maturation for fruit

and vegetable. Also used as post-harvest ripening agent (Adams and Yang , 1979).

Ethephon (Ethrel) may be used for uniform ripening for once-over harvest and to enhance ripening in late varieties, or during late seasons, or when ripening is delayed (Ku, *et al.*, 1970). The proper use of Ethrel can advance harvest about 5-7 days. Fruit do not increase appreciably in size after ethephon treatment

Several factors must be considered for effective use of Ethrel:

- Because Ethrel can cause some defoliation and increase incidence of sunburned fruit, do not treat fields where growth is poor or the plants are stressed.
- Do not apply Ethrel if temperatures are expected to exceed 90 F.
- Apply when fruit is at 5 to 10% red/pink/breaker stage. Ethrel is effective only on fruit that is at least mature-green (fruit has gel inside). The key to good results is good coverage.
- Apply 1.25 to 1.75 pints Ethrel (2 lb/gal formulation) in 40-80 gal water/acre. Use higher rates when day temperatures are less than 64 F and tomato growth is dense. Ideal temperature range is 75-85 F.
- Avoid spraying more than can be harvested in one day as sprayed fields do not "store" as well as unsprayed.
- Varietal differences in foliage vigor and leaf characteristics affect Ethrel uptake and potential for fruit injury and ripening response. Experiment carefully and know how your variety responds.
- Do not exceed 6.5 pints/acre total, or excess residues may develop.

Harvest fruit at proper maturity, generally 14 to 21 days after treatment. Observe treated fruit frequently for condition of crop ripening. Cool temperatures can slow

Ethrel absorption and color development and extend the period between treatment and harvest (Lacheene, 1990).

According to (Elsadig and James, 1996) Fruit ripening in normal red-, orange- and yellow-fruited cultivars of tomato was accelerated by treatment with Ethrel and such fruits had lower tomatine levels than untreated controls. Fruits in which ripening was retarded by incubating under reduced pressure had higher alkaloid levels than controls. In each case, fruit ripeness (as measured by pigmentation) showed a strong negative correlation with fruit tomatine. Ethrel treatment of fruits of the non-ripening mutants *nor* and *rin* caused only a small development of carotenoid pigment but markedly enhanced tomatine disappearance. Pigmentation and tomatine were again negatively correlated although the quantitative relationship differed. Under normal circumstances, tomatine disappearance from tomato fruits-is apparently governed by the physiological (cf. chronological) age of the fruit rather than by its growth or ripening characteristics alone.

2. 3. Effect of Hormone on ripening of Tomato

It has been reported that exogenous ethylene application induced CD in potato tubers (Ilker, et al., 1977), pine (Barker 1979) and aquatic plants (Metzer, 1984) as well as CE in rice (Kuo, *et al.*, 1970, Smith and Robertson, 1971), aquatic plants (Metzer, 1984) and fig fruits (Maxi and Crane, 1968). In pea apex and root (Apelbaum and Burg, 1972) as well as fig fruit (Maxi and Crane, 1968), however, exogenous ethylene application depressed only CD but increased CE. Increasing or inhibiting ethylene levels at a certain developmental stage may, therefore, but used as a tool for magnifying or modifying fruit growth pattern.

Ethrel is a chemical that we can apply to plant tissue to accelerate the production of ethylene (plant hormone) which accelerates senescence and/or fruit ripening

(Abdel-Rahman, 1977, Atta-Aly, 1988, Elsadig and Beltagy, et al., 1996). Ethrel is a plant growth regulator registered on a range of crops including, Sugarcane, Barley, Citrus, Tomatoes, Apples, Grapes, Macadamia, Pineapples, Peaches and Cherries. Ethrel is used as a management tool, to aid maturity and colour development (Apples, grapes, Tomatoes, Pineapples, Peaches and Cherries), or, to aid fruit thinning for reducing crop load (Citrus, Apples) (Iwahori, 1967, Nitsch and Nitsch, 1961). In Macadamias it is used as a harvest aid by promoting even nut fall. In Pineapples it is also used for flower initiation. In tomatoes Ethrel is an effective and efficient crop management tool. Ethrel helps ripen fruit quickly and uniformly, thereby allowing meeting our picking schedules. Only mature green fruit will ripen after being treated with Ethrel. One Ethrel is applied no new fruit will form. Cooler conditions effect the colour change of the fruits allows longer pre-harvest intervals under these conditions. In some cases Ethrel may cause some yellowing of foliage or defoliation. Under hot conditions exposed fruit may become sun scalded after treatment.

During its ontogeny, tomato fruit passes through certain developmental stages. First and directly after set, fruit passes through a short period of growth characterized by its slow rate. This slow rate of growth during such very early period due entirely to the dominant process of CD (Davis and Cooking 1985, Gillasp, et al., 1993). Fruit was then passed through a long period of rapid growth as fruit cells transmit to the stage of CE (Iwahori, 1967); N cells transmit to the stage of CE (Iwahori, 1967, Nitsch and Nitsch, 1961). The length of such rapid growth period is strongly controlled by either tomato cultivar or the environmental coincide factors (Lacheene, 1990). The third developmental stage was then occurred and last for about two additional weeks of a slow growth rate by which the fruit gained little more weight and reached maturation (Abdel-Rahman, 1977). Two or three days later, fruit ripening was initiated (Atta-Aly, *et*

al., 1992). These facts strongly indicated that tomato fruit growth pattern followed the single sigmoid growth curve (Rhodes, 1980). This may also lead to the demonstration that the ultimate size of tomato fruit is determined during its very early stages of development (Houghtaling, 1935). The extent and relative importance of CD and expansion may, therefore, play a pivotal role, as key factors, in controlling not only tomato fruit size and shape but also fruit total yield. Ethylene, as a plant hormone, is produced by many fruits even during their early stages of growth and development (Atta- Aly, 1988, Burg and Burg, 1965). It was thought that this early production of ethylene is responsible for young fruit abscission until (Maxie and Crane, 1968) revealed that the increased level of ethylene produced by young fig fruit was the reason behind early fruit growth. It was then believed that ethylene may have major and significant roles in fruit development during its ontogeny. The increased levels of ethylene production during fruit early stages of development was observed in many fruit species including tomato (Abdel and Rahman, 1977, Atta-Aly, 1988, Elsadig and Beltagy, *et al.*, 1996), sycamore fig (Maxie and Crane, 1968), peach (Looney *et al.*, 1974) and apple and cherry (Blanpied, 1972). In tomato, the early peak of endogenous ethylene occurred during the very early stage of fruit development was shortly followed by a gradual decrease, reaching a stable low level until ripening onset when another increase was observed with the beginning of climacteric rise (Abdel and Rahman, 1977, Atta-Aly, 1988, Elsadig and Beltagy *et al.*, 1996). Same trend was also found regarding tomato fruit content of ACC (Atta-Aly, 1988) as an immediate ethylene precursor (Adams and Yang, 1979).

The tomato (*L. Karsten*) is an important crop cultivated in Hungary. Ethrel has been used to advance maturity and promote uniform processing tomato ripening since 25–30 years in Hungary. The aims 1) to evaluate the effects of two different

ethrel concentrations on ripening rate, 2) to investigate lycopene content of different maturity stages, 3) to test the effect of ethrel on lycopene content. It is important to note that the experimental year (in July and August) was very rainy and cool. Ethrel (Abdel and Rahman, 1977) was applied at two rates: solution = 1500 and 3000 ppm. The experiment results clearly indicate that Ethrel can be a useful and effective maturity-enhancement tool, under the circumstances. Ripening concentration increased significantly by Ethrel. In spite of this, Ethrel treatments did not affect significantly for examined varieties of lycopene content. The quality of tomato yields or products can be well characterised by their lycopene content. Colour is a most important quality factor in consumer perception of food products. The range in lycopene contents from all samples evaluated was 48.7 to 113.0 mg kg⁻¹ fresh weight. Correlations between lycopene content and colour were investigated also.

In a preliminary experiment, conducted earlier in this work, it was found that applying ethrel, as an ethylene releaser, to tomato flowers 2 days after anthesis with concentrations higher than 100 ppm induced flower abscission while concentrations of 50 ppm or less had no impact on fruit growth as measured by fruit diameter and fresh weight. Applying 100 ppm however, proved to be the best ethrel concentration to be used in terms of eliminating flower abscission and shifting fruit growth pattern measured as fruit diameter and fresh weight. Therefore, and to test the impact of ethylene on CD and CE as well as the transition phase between both developmental processes, tomato flowers were sprayed at set (2 days after anthesis as previously reported by Elsadig and Beltagy *et al.*, 1976) with 100 ppm ethrel, 0.5 mM AOA (aminooxyacetic acid) and H₂O (as control). AOA is known by its inhibition to ethylene biosynthesis through inhibiting ACC (1-aminocyclopropane-1-carboxylic acid) synthesis (Yang, 1980).

CE. This was also supported by measuring ethylene emanation by such fruits since, in all treatments, the onset of fruit rapid growth period as well as the significant increase in CE and the almost termination of CD proved to be coincide with the time of ethylene drop to its basal level. Data presented in showed that fruits of AOA treated flowers reached its basal level of ethylene production as early as 6-8 days after anthesis. By that time such fruits reached the onset of its rapid growth period as indicated by the significant increase in fruit fresh and dry weights, and CE as well as the almost termination of its CD. This was also noticed in control and in fruits of ethrel treated flowers but after 10 and 18 days from anthesis, respectively. It is of interest to note that the early drop in ethylene production, regardless the sort of treatment, due mainly to the strong inhibition of ethylene biosynthesis since the level of ACC followed the same pattern of C_2H_4 drop by a period of about 24 h. Fruits of AOA treated flowers showed the earliest ACC drop, noticed 10 days after anthesis, followed by control and those of ethrel applied fruits 12 and 18 days after anthesis, respectively. The higher ethylene and ACC levels noticed during the early stage of fruit development with ethrel application in comparison to those of control or AOA treated ones, may due to the higher levels of ethylene positive feed back mechanism (Atta-Aly *et al.*, 1994). On the other hand, the significant increase in ACC level of all treatments during fruit early development may due to the low levels of ACC conversion to C_2H_4 since a marked drop in ethylene production was obtained during such period. It is also of interest to note that the degree of ACC accumulation during such period negatively correlated with ethylene production as affected by the different flower treatments. fected by the different flower treatments (Abdel and Rahman, 1977, Atta-Aly, 1988, Elsadig and Beltagy *et al.*, 1976).

Chapter three
Materials and Methods

CHAPTER THREE

Materials and Methods

The materials and methods used in conducting the present experiment have been presented in this chapter. The chapter deals with a short description of location of the experiment plot, characteristics of soil, climate and materials used for the experiment. The details of the experiment and its methods used are described below.

3. Location of the experiment area/plot

The field experiment in this thesis were conducted at the Horticulture Research Centre (H.R.C.), the Regional Agricultural Research Station (RARS), Bangladesh Agricultural Research Institute (BARI), Jessore.

3.1. Preparation of the nursery

3.1.1. Planting materials

The experiment was conducted with Bari Tomato-4. Both mature and immature tomatos were used.

3.1.2. Essential Equipments and Chemicals

3.1.2.1. Equipments

- 1) Scissors
- 2) Conical flask
- 3) Pipette
- 4) Spray machine
- 5) Basket

- 6) Balance (electronic)
- 7) Aluminum foil
- 8) Measurement flask

3.1.2.2. Chemicals

- 1) Etherel (2-chloroethyl phosphonic acid)

3.2. Cultivation Procedure of Tomato

3.2.1. Land Preparation

The selected land for the experiment was first opened with a power tiller. Then it was exposed to the sunlight for seven days prior to the next ploughing. After that, the experimental plot was properly prepared through several ploughing and cross ploughing to obtain a good tilth. Deep ploughing was done for getting better yield of the crop. All weeds and stubbles were removed from the field and bigger clods were broken into tiny pieces by laddering and mallet during land preparation.

3.2.2. Design and layout of the experiment:

The experiment was laid out in Randomized Complete Block Design (RCB) with three replications. There were (4) treatment combinations and the treatments were replicated three times. The whole experimental area was (20) m x (8) m which was divided into 3 blocks. Each block was divided into 4 plots where 4 treatments combinations were allocated at random. The unit plot size was 4.0m x 1.0m. Row to row and plant to plant distance were maintained by 50cm and 40cm respectively.

3.2.3. Application of manure and fertilizer:

The land were fertilized with cow dung, urea, TSP (Triple Super Phosphate) MOP (Murate of Potash) and gypsum @ 10000, 550, 450, 250 and 111 kg/ha respectively. The total amount of cow dung, TSP and gypsum and 1/3rd of each of urea and MOP were applied in pit one week before transplanting. The rest of urea and MOP were applied in two equal installments at 21 and 35 days after transplanting.

3.2.4. Seed sowing seedling transplanting:

Seeds were sown on 17 May 2008 for experiment.. Forty five day old seedlings were planted in the main field on 27 June 2008.

3.2.5. Intercultural Operation

The plants were grown with support in polyethylene made rain shelter. Intercultural operations were done as and when necessary.

3.2.6. Thinning :

Emergence of seedlings started 7 days after sowing of seeds. Seedlings were thinned out two times. First thinning was done 20 days after sowing and the second was done 30 days after sowing.

3.2.7. Irrigation

Irrigation was done followed by weeding, as when necessary, to keep the plots free from weeds and to supply soil moisture.

3.2.8. Disease and pest management:

The crop was free from insect and no insecticide was used but leaf curl virus disease infection was found. The infected plants were removed from the plot and destroyed the infected plants. Viral disease spread by white fly. So, Admire-200 SL @ 1 ml/L water was sprayed to control the white fly.

3.3. Preparation of Etherel (2-chloroethyl phosphonic acid) Stock Solution:

The experiment was conducted with Ethrel 48 SL growth regulator. Main constituent of Ethrel is Ethepone 48 S.L (2 chloroethyl phosponic Acid) was obtained formulated as the commercially available 100% pure (Sigma Company Limited). The stock solution and working solution were prepared in the laboratory of Horticulture center for spraying on the experimental Winter tomato(both mature and immature) lines.

3.3.1. Preparation of 100ppm stock solution:

Ethrel which was collected from local market. Stock solution was prepared in 100 ppm by dissolving 65 mg of ethrel in 10 ml water. The mixture was collected in 100 ml measuring flask and the volume was made up to 100 ml by further addition of distilled water. Stock solution was then transferred into a conical flask; opening of the flask was wrapped with aluminum foil and stored in the refrigerator.

3.3.2. Preparation of working solution

Etherel (2-chloroethyl phosphonic acid) of required quantity was made from the stock solution by the following formula:

$$V_1S_1 = V_2S_2$$

Here,

V_1 = Volume of stock solution (ml)

S_1 = Strength of stock solution (ppm)

V_2 = Volume of working solution (ml)

S_2 = Strength of working solution (ppm: 100)

3.4. Method of Ethrel Application:

100 ppm was applied in a set of 5 fruits to observe the effectiveness of days to ripening, TSS, skin colour, shelf life and taste. Spraying ethrel at a concentration (100ppm) just like fog or dissolved fruits for 3 min and then dried one hour in the sun.

3.5. Sampling:

Five fruits were selected from the BARI Hybrid - 4 and BARI Hybrid - 5 tomato of each unit plot and marked by bamboo stick for collection of data. The fruits in the outer rows and the extreme end of the middle rows were excluded from the random selection to avoid side effect. Following parameters were recorded from the selected fruits during the course of experiment and the mean value for every parameter was also recorded.

3.6. Date of spraying of Ethrel:

Ethrel was Sprayed at the rate of 100 ppm on both mature and immature fruits of BARI – 4 and BARI – 5 Tomato.

3.6.1. Treatments:

1. 100 ppm ethrel
2. Factor – A

i. BARI Tomato – 4

ii. BARI Tomato – 5

3. Factor – B

i. Mature Tomato

ii. Immature Tomato

4. Factor – C

i. Hormone Application

ii. Water Application

3.6.2. Days to ripening

Immature (20 days after fruits) and fully mature (30-35 days) fruits that were harvested from Bari-4 hybrid tomato ethrel was spraying to determine the individual days to ripen. Ripening was recorded in days.

3.6.3. Total Soluble Solid (TSS)

Effect of ethrel on total soluble solid after ripening was recorded. TSS was recorded in percent.

3.6.4. Skin Color of Tomato

Effect on treated and untreated fruits with 2- Chloroethyl Phosphonic acid (Ethrel) on skin color of tomato after ripening was recorded. Skin color was recorded in 1-10 scoring scale.

3.6.5. Shelf Life of Tomato

Effect of ethrel on shelf life of both mature and immature tomato fruits after ripening was recorded. Shelf life was recorded from days to harvest.

3.6.6. Organoleptic Test

Effect of ethrel on organoleptic taste of tomato after ripening was recorded. The data was recorded depend on taste.

3.7. Data Collection and Statistical Analysis

Weekly Visual observation of the fruits was made and frequency of the mature and immature fruits showing the effect of ethrel on days to ripening, percent of total soluble solid (TSS), skin colour, organoleptic taste and shelf life of tomato after ripening was recorded. The data pertaining were analyzed subjected to Duncan's New Multiple Range Test (DMRT).

Chapter four
Results and Discussion

CHAPTER FOUR

Results and Discussion

The experiment was conducted at the Horticulture Research Centre (H.R.C.), Regional Agricultural Research Station (RARS), Jessore. In this experiment 100 ml ethrel was sprayed on both mature and immature BARI Hybrid-4 and BARI Hybrid-5 tomatoes for decreasing day to ripening, increasing TSS, skin colour, shelf life and taste.

4. Effect of ethrel on ripening of both mature and immature tomato

One hundred ppm ethrel was sprayed on both mature and immature tomatoes to observe its quantitative effects mentioned above. A control treatment was also carried out

Table.1. Effect of ethrel on ripening of BARI hybrid-4 tomato.

Treatment	Days to ripening	TSS (%)	Skin color(1-10 scale)	Shelf Life(Days)
A (Immature with water)	10.33d	2.00b	2.67c	11.67c
B (Immature with Ethrel)	7.33c	2.00b	4.67b	12.00bc
C (Mature with water)	4.00b	3.33a	8.33a	14.33ab
D (Mature with ethrel)	2.67a	4.33a	10.00a	14.67a
CV	9.0866	20.6032	14.6931	9.7230
LSD	1.1044	1.2006	1.8836	2.5577

(Different letters within same legend columns are significantly different at 0.05

Levels and means with the same letter in a column do not differ significantly.)

CV=Co-efficient Factor

LSD=Least Significant Difference

In BARI Hybrid-4 mature fruit treated with ethrel were significantly different than immature fruits treated with ethrel for decreasing days to ripening. In mature

In BARI Hybrid-4 mature fruit treated with ethrel were significantly different than immature fruits treated with ethrel for decreasing days to ripening. In mature fruits it takes approximately 3 days to ripe and immature fruits it takes 7 days which was significantly different (Table-1) and (Fig – 10). Significant difference was also observed between treated and control treatment regarding days to ripe of mature tomato BARI hybrid-4. When mature tomato fruits were treated with water it takes 4 days to ripe and in case if immature tomato fruits it takes 10 days to ripe and when immature fruits were treated with ethrel and without ethrel they were also significantly different. From the (table-1) it was found that the application of ethrel was more suitable for mature tomato fruits for decreasing day to ripe.



Fig.4. BARI Hybrid-4 tomato before using ethrel.



Fig.5. BARI Hybrid-4 tomato after using ethrel.

4.1. Comparison between the effectiveness of Days to ripening, TSS, Skin color and Shelf life of BARI - 4 and BARI -5 Tomato:

The Chinese may have been the first to observe the effects of ethylene when they noted that burning incense increased fruit ripening. In 1864 leaks in gas lights in street lamps were reported to stunt plant growth and defoliate trees. In 1901, D. Neljubow realized that his dark-grown pea seedlings were short, fat and negatively gravitropic (the triple response) because of a component in "laboratory air" which he subsequently identified as ethylene. Cousins (1910) first reported that ethylene occurred in plants.

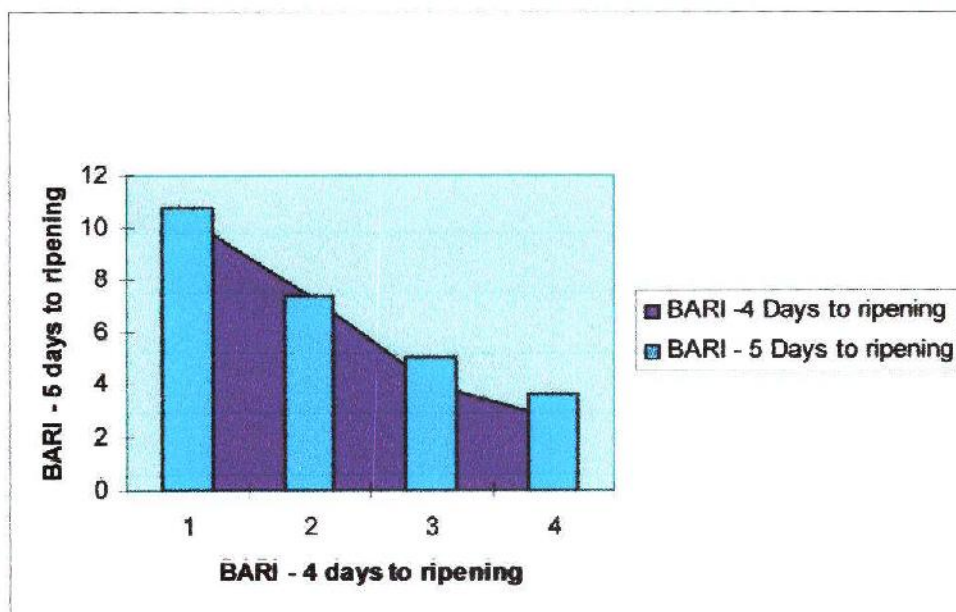


Fig. 6. Effect of ethrel on days to Ripening of both BARI -4 and BARI - 5 Tomato.

Ethrel was applied at two rates: solution = 1500 and 3000 ppm. The experiment results clearly indicate that Ethrel can be a useful and effective maturity-enhancement tool, under the circumstances. Ripening concentration increased significantly by Ethrel (Elsadig and Beltagy *et al.*, 1996). In spite of this, Ethrel treatments did not affect significantly for examined varieties of lycopene content. The quality of tomato yields or products can be well characterised by their lycopene content. Colour is a most important quality factor in consumer perception of food products. The range in lycopene contents from all samples evaluated was 48.7 to 113.0 mg kg⁻¹ fresh weight. Correlations between lycopene content and colour were investigated also.

Some commercial greenhouse operators use a product called Ethrel. Spraying with this ethylene-releasing compound will trigger mature green fruit to ripen. Use 200 ml of Ethrel to 100 liters of water, and spray to cover all fruit required for ripening. For best results, moderate to high temperatures and humidity are desirable. Temperatures higher than 18 degrees C. are best. Harvest 10 to 14 days after application. This naturally occurring ripening hormone is available from greenhouse suppliers. (Yang, 1980)

The tomato (L) Karsten) is an important crop cultivated in Hungary. (Helyes and Lugasi, et al., 1960) Ethrel has been used to advance maturity and promote uniform processing tomato ripening since 25–30 years in Hungary.

Mature fruit treated with ethrel was significantly different than immature fruits treated with ethrel for increasing TSS (Table-1) and (Fig – 11) but when mature fruits are treated with ethrel and control was insignificantly different. In mature fruits TSS was 4.33 and immature fruits TSS was 2.00. Control treatments of mature and immature tomato fruits were also significantly different at 5% level.

When mature tomato fruits were treated with water TSS is 3.33 and in case if immature tomato fruits it was 2.00. From the (table-1) it was found that the application of ethrel for increasing TSS sprayed when fruits were in trees.

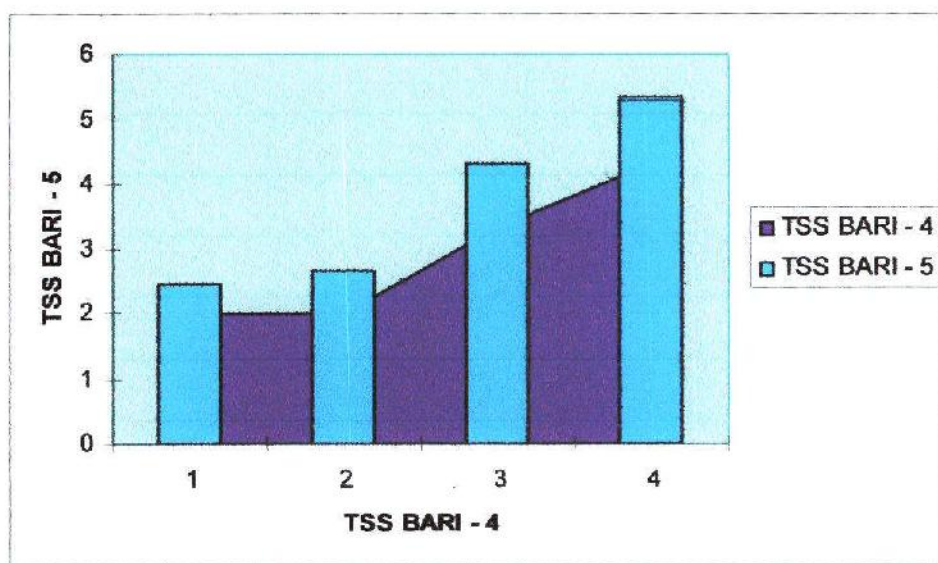


Fig .7. Effect of ethrel on TSS of both BARI -4 and BARI – 5 Tomato.

When ethrel a dilute solution of 2-chloroethylphosphonic acid breaks down and produce ethylene gas. Ethylene that controls ripening, sweetening and fruit color. It occurs naturally in plants, in which it acts as a growth substance (hormone) promoting the ripening of fruits and senescence of organs and increase TSS (*John Harmon, 2001*). In Tomato Puree ,Total Soluble Solids (TSS) was: 9.5 +1% and Tomato Ketchup, Total Soluble Solids (TSS) was:37 +- 1% (W/W)

A field experiment was carried out on a Granby sandy loam soil at Harrow, Ontario. The experiment consisted of 4 drip irrigation water levels (1.2 times

potential crop evapotranspiration (ETc), 1.0 ETc, 0.8 ETc and 0.5 ETc) with an un-irrigated control treatment and 3 pre-harvest water cut-off times (4, 3 and 2 weeks before anticipated harvest). (Elasdig and James , 1996) Irrigation increased total yield from 114.4 t/ha to 131.7 t/ha and increased marketable yield from 111.3 to 128.8 t/ha. However, there was no significant difference ($P > 0.05$) in yield between the different water levels (ETc values). Both total and marketable yield tended to be higher with the later pre-harvest water cut-off times (2 and 3 weeks before harvest) compared to the water cut-off 4 weeks before harvest. Soluble solids (% Brix) and total solids (%) were both negatively affected by drip irrigation. As the amount of water applied through drip irrigation increased, the percent solids level decreased. The preharvest water cut-off times did not affect the % solids levels. Deficit irrigation (0.5 ETc) during a wet year will allow a grower to reduce water use without suffering a loss in yield and maintaining a relatively high tomato fruit solids level.

Mature fruits treated with ethrel were significantly different than immature fruits treated with ethrel for skin color of tomato. In mature fruits the scale of skin color was 10.00 and immature fruits it was 4.67 (Table-1) and (Fig-12). Mature fruits treated with ethrel and control insignificant. Control treatments of mature and immature tomato fruits were also significantly different at 5% level. When mature tomato fruits were treated with water the scale of skin color was 8.33 and immature fruits it was 2.67 respectively. Immature fruits were treated with ethrel and without ethrel were also significantly different.



Fig.8. Skin color of both Mature and Immature BARI Hybrid-4 tomato.

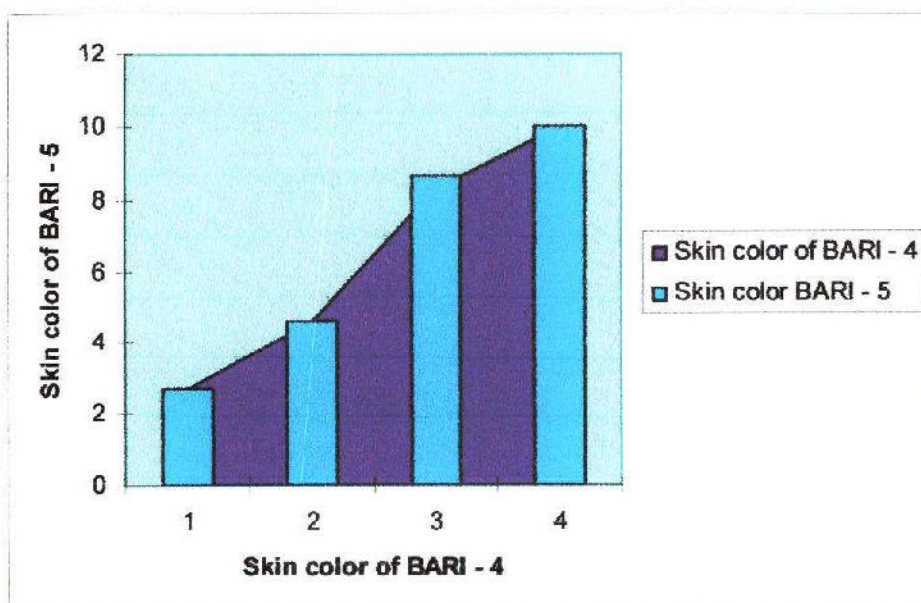


Fig. 9. Effect of ethrel on Skin color of both BARI -4 and BARI - 5 Tomato.

Fruit ripening in normal red-, orange- and yellow-fruited cultivars of tomato was accelerated by treatment with Ethrel (Elsadig and James, 1996) and such fruits had lower tomatine levels than untreated controls. Fruits in which ripening was retarded by incubating under reduced pressure had higher alkaloid levels than controls. In each case, fruit ripeness (as measured by pigmentation) showed a strong negative correlation with fruit tomatine. Ethrel treatment of fruits of the

non-ripening mutants *nor* and *rin* caused only a small development of carotenoid pigment but markedly enhanced tomatine disappearance. Pigmentation and tomatine were again negatively correlated although the quantitative relationship differed. Under normal circumstances, tomatine disappearance from tomato fruits is apparently governed by the physiological (cf. chronological) age of the fruit rather than by its growth or ripening characteristics alone.

Mature fruit treated with ethrel were significantly different than immature fruits treated with ethrel for shelf life (days) of tomato. In mature fruits the shelf life of tomato was approximately 15.00 days and immature fruits it was 12.00 days which was significantly different (Table-1) and (Fig -13). Significant difference was also observed between treated and control treatment regarding shelf life of mature tomato Bari hybrid-4. When mature tomato fruits were treated with water the shelf life of tomato was 14.33 days and immature fruits it was 11.67 days. Immature fruits were treated with ethrel and without ethrel were also significantly different. Shelf life of the tomatoes the highest result were observed in mature fruit treated with ethrel that was superior to immature fruits treated with ethrel and immature treated with water.

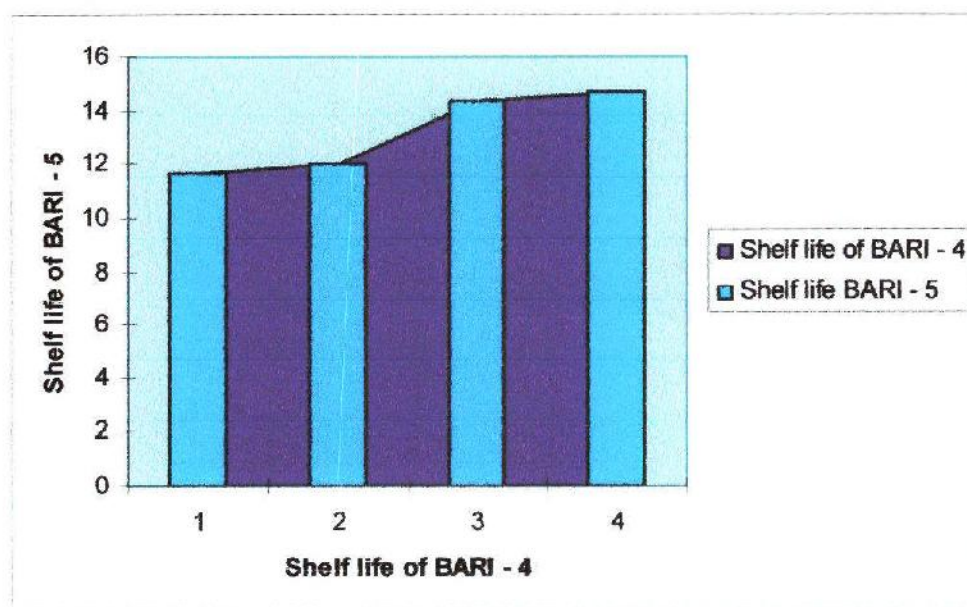


Fig. 10. Effect of ethrel on Shelf life of both BARI -4 and BARI – 5 Tomato.

Parameters of tomato fruit growth, measured as fruit diameter as well as fresh and dry weights showed a period of slow growth during the 20 days after anthesis. This was followed by a period of rapid growth up to 30-35 days after anthesis when the second slow growth period was occurred and last until fruit reached its maturation. During the early period of tomato fruit slow growth, CD took place (Davis and Cooking, 1965, Gillaspay et al., 1993), while fruit rapid growth period due entirely to CE (Iwahori, 1967, Nitsch and Nitsch, 1961). These findings, therefore, strongly suggested that the transition phase from CD to CE in tomato fruit cv. Castel Rock may be an ethylene dependent process. It was also found that tomato fruit produced a remarkable level of ethylene during the stage of CD while an opposite trend was occurred during CE and the remarkable drop in ethylene level was parallel in time to the noticed transition phase between both developmental processes.

Table.2. Effect of ethrel on ripening of BARI hybrid-5 tomato.

Treatment	Days to ripening	TSS (%)	Skin color(1-10 scale)	Shelf Life(Days)
A (Immature with water)	10.73d	2.46b	2.67c	11.67c
B (Immature with Ethrel)	7.33c	2.67b	4.67b	12.00bc
C (Mature with water)	5.00b	4.33a	8.67a	14.33ab
D(Mature with ethrel)	3.67a	5.33a	10.00a	14.67a
CV	10.0866	22.6142	14.6931	9.7230
LSD	1.2088	1.4006	1.8836	2.5577

(Different letters within same legend columns are significantly different at 0.05 levels and means with the same letter in a column do not differ significantly.

In BARI Hybrid-5 mature fruit treated with ethrel were significantly different than immature fruits treated with ethrel for decreasing days to ripening. In mature fruits it takes approximately 4 days to ripe and immature fruits it takes 7 days to ripe which was significantly different (Table-2) and (Fig -10). . Significant difference was also observed between treated and control treatment regarding days to ripe of mature tomato BARI hybrid-5. When mature tomato fruits were treated with water it takes 5 days to ripe and in case of immature tomato fruits it takes approximately 11 days to ripe and when immature fruits were treated with ethrel and without ethrel they were also significantly different. From the (table-2) it was found that the application of ethrel was more superior for mature tomato fruits for decreasing day to ripe than mature fruits treated with water and immature fruits treated with ethrel and water. . Compare to BARI Hybrid-4, BARI Hybrid-5 tomato takes more time for ripening.

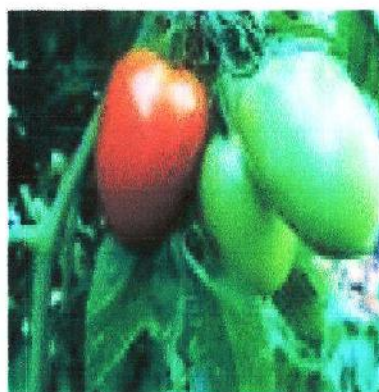


Fig.11. BARI Hybrid-5 Tomato before using ethrel.

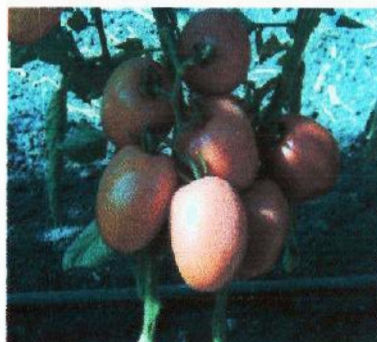


Fig.12. BARI Hybrid-5 Tomato after using ethrel.

In BARI Hybrid-5 mature fruits treated with ethrel were significantly different than immature fruits treated with ethrel for increasing TSS but when mature fruits were treated with ethrel and control was insignificant. In mature fruits TSS was 5.33 and immature fruits TSS was 2.67 (Table-2) and (Fig -11). Control treatments of mature and immature tomato fruits were also significantly different but when immature fruits were treated with ethrel and control they were insignificant. When mature tomato fruits were treated with water TSS was 4.33 and in case of immature tomato fruits it was 2.46. Compare to BARI Hybrid-4, in BARI Hybrid-5 tomato TSS is high.

In BARI Hybrid-5 mature fruits treated with ethrel were significantly different than immature fruits treated with ethrel for skin color of tomato. In mature fruits the scale of skin color was 10.00 and immature fruits it was 4.67 (Table-2) and (Fig -12). Mature fruits treated with ethrel and control was insignificant. Control

treatments of mature and immature tomato fruits were also significantly different at 5% level. When mature tomato fruits were treated with water the scale of skin color was 8.67 and immature fruits it was 2.67 respectively. Immature fruits were treated with ethrel and without ethrel are also significantly different.



Fig .13 . Skin color of both Mature and Immature BARI Hybrid-5 tomato.

In BARI Hybrid-5 mature fruit treated with ethrel were significantly different than immature fruits treated with ethrel for shelf life (days) of tomato. In mature fruits the shelf life of tomato is approximately 15.00 days and immature fruits it was 12.00 days (Table-2 and (Fig -13). Mature fruits are treated with ethrel and control was also significantly different. When mature tomato fruits were treated with water the shelf life of tomato was 14.33 days and immature fruits it was 11.67 days. Immature fruits were treated with ethrel and control was also significantly different. Shelf life of the tomatoes the highest result were observed in mature fruit treated with ethrel that was superior to immature fruits treated with ethrel and immature treated with water. This was similar to BARI Hybrid-4.

Table.3. effect of ethrel on organoleptic test BARI Hybrid-4 and BARI Hybrid-5 tomato after Ripening.

Stage of maturity ((after fruit sets)	Treated and untreated with PGR	Organoleptic test
20 days after fruit set	immature with water	Unpleasant
20 days after fruit set	immature with ethrel	Unpleasant
30-35 days	mature with water	Pleasant
30-35 days	mature with ethrel	Good

Organoleptic Test for both BARI Hybrid-4 and BARI Hybrid-5 were same. Organoleptic test depends on taste. Better result was observed when mature fruits (30-35 days) were treated with ethrel, it taste was good compare to immature (20 days after fruit set) fruits treated with ethrel and water. It taste was unpleasant and pleasant result was found when mature (30-35 days) fruits were treated with water (Table-3).

In a preliminary experiment, conducted earlier in this work, it was found that applying ethrel, as an ethylene releaser, to tomato flowers 30-35 days after fruit sets with concentrations higher than 100 ppm induced flower abscission while concentrations of 50 ppm or less had no impact on fruit growth as measured by days to ripening, skin color, taste and shelf life. Applying 100 ppm however, proved to be the best ethrel concentration to be used in terms of eliminating flower abscission and shifting fruit growth pattern measured as skin color, days to ripening, taste and shelf life. Therefore, and to test the impact of ethylene on CD

and CEAs well as the transition phase between both developmental processes, tomato flowers were sprayed at set (2 days after anthesis as previously reported by (Elsadig and Beltagy, *et al.*, 1996) with 100 ppm ethrel, 0.5 mM AOA (aminooxyacetic acid) and H₂O (Water). AOA is known by its inhibition to ethylene biosynthesis through inhibiting ACC synthesis (Yang, 1980). It has also been found that 0.5 mM is the most suitable concentration of AOA to be used for inhibiting ethylene biosynthesis in tomato fruits (Atta-Aly, 1992).

Use of ethrel for ripening of tomato is safer than other PGR due to its lack of overt toxicity in subchronic dietary studies, the lack of acute dietary exposure concern, and the low volume/minor use status. (United States EPA, 1997). For the primary introduction of higher percentage of fruit set, establishment of the optimum dose of ethrel was essential. Ethrel is not harmful for human and animals because their physiological effects stay only three days and it cannot enter inside the tomato fruits.

In the present study, 100 ppm of ethrel was examined to investigate the ripening fruit in compare to water. Ethrel at 100 ppm of both mature and immature fruits were found to decrease days to ripening, increase TSS (%), skin color (1-10 scoring) and shelf life (from days to harvest).

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Chapter Five
Summary and Conclusion

CHAPTER FIVE

Summery and Conclusion

The experiment was conducted at Horticulture Research Centre (HRC), Regional Agricultural Research Station (RARS), Bangladesh Agricultural Research Institute (BARI), Jessore during May 2008 to June 2008.

The experiment was laid out in randomized complete block design (RCB) with three replications. The selected lands for the experiments were prepared properly through several ploughing and cross ploughing. Fertilization, weed management and intercultural operations were done to ensure proper growth of the hybrid varieties.

The research was carried out to(1) clarify the effect of ethrel on ripening of both mature and immature summer tomato.(2)to identify the response of ethrel in fruit size, color, shelf life.and (3) to study the increase of fruit quality(especially total soluble solid/sugar).

The experiment was carried out with materials BARI tomato-4 and BARI tomato-5. Four treatments were used. Treatment-1 was immature fruits with water, Treatment-2 was immature fruits with ethrel, Treatment-3 was mature fruits with water and Treatment-4 was mature fruits with ethrel.

In the experiment ethrel was sprayed 20 days stage after fruit sets and full ripening (30-35 days) on both mature and immature tomatoes. Better result was found when ethrel was used in mature tomatoes both BARI hybrid-4 and BARI

hybrid-5 compare to immature fruits and water treatment for decreasing days to ripening, increasing TSS, Shelf life, Skin color and test. Highest result was found in Days to ripening 2.67 days (BARI -4) and 3.67 days (BARI -5) when mature fruits treated with ethrel and lowest result were 10.33 days (BARI -4) and 10.73 days (BARI -5) when immature fruits treated with water, in case of TSS (%) highest result were 4.33 (BARI -4) and 5.33 (BARI -5) and lowest were 2.00 (BARI -4) and 2.46 (BARI -5), in case of Skin color (1-10 scale) highest result were 10.00 (BARI -4) and 10.00 (BARI -5), and lowest was 2.67 in both variety of BARI - 4 and BARI -5 and in case of Shelf life highest result was 14.67 in both variety of BARI - 4 and BARI -5 and lowest was 11.67 in both variety of BARI - 4 and BARI -5 and taste was also good in both variety when mature fruits treated with ethrel and taste was unpleasant when treated with water.

Generally, tomato is consumed freshly as salad and culinary purposes. Development of processing techniques has high potential of export value of tomato. However, traditional cultivars of tomato are not suitable for processing due to high seed content and high juices. Process of globalization is demanding cultivars of tomato for processing, juices, sauces, and catch-up and other ready to serve foods for the millennium peoples.

Finally for ripening fruits our farmer used harmful chemicals which not only effect on plants but also cause several diseases to human. The findings of the study was to used chemical which has no harmful effect on plants animals and human also which takes limited time for ripening of summer tomato, increase its TSS, excellent skin color, increase shelf life and excellent taste.

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