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EFFECT OF 1-METHYLCYCLOPROPENE ON RIPENING AND ASSOCIATED PARAMETERS IN TOMATO FRUITS

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SUMMARY

Tomato (*Lycopersicon esculentum* Mill.) cv. Pusa Ruby and Pusa Gaurav fruits were harvested at mature green stage and exposed to 1-MCP evolved from ethylbloc at concentrations of 1µl/l and 5µl/l for 4 hours, at 28±2°C. The fruits were then stored at room temperature (28± 2°C). The treatment of 5µl/l of 1-MCP delayed ripening by four days in both the varieties. Respiration rate, chlorophyll, lycopene, carotenoid contents and polygalacturonase activity were determined in mature green fruits just before treatment and at half ripe and full ripe stages. 1-MCP treatment not only delayed lycopene accumulation but also significantly reduced its magnitude. However, total carotenoids content was enhanced by 1-MCP treatment. Polygalacturonase activity was highly inhibited by 1-MCP at half ripe stage, but did not affect it at full ripe stage. The results imply that 1-MCP could be effective in delaying the ripening process in tomato fruits under tropical condition.

Key words*: *1-Methylcyclopropene, polygalacturonase, ripening, tomato

INTRODUCTION

1-Methylcyclopropene is a highly effective inhibitor of ethylene action due to competitive binding on the ethylene receptor on the plant tissues (Sisler and Wood 1988, Sisler *et al.* 1996, Sisler and Serek 1997). 1-MCP has been approved by the US Environmental Protection Agency as a reduced risk product for use on consumable produce (Bai *et al*. 2005). Depending on the species being treated, 1-MCP has a variety of effects on respiration, ethylene and volatile production, pigment changes, membrane and protein changes, softening, acidity and sugars (Blankenship and Dole 2003). 1-MCP has been found to extend the storage life of a range of fruits and vegetables including plum, strawberry, banana, apple, tomato and various ornamentals (Serek *et al*. 1995, Abdi *et al*. 1998, Ku *et al*. 1999, Harris *et al*. 2000, Wills and Ku 2002, Aymard *et al*. 2003). The chemical significantly delays and suppresses the onset and magnitude of respiration in mature banana fruits (Golding *et al*. 1999). The treatment completely suppressed increase in polygalacturonase activity for upto 12 days and these effects were influenced by concentration, exposure duration and temperature (Jeong *et al*. 2002). In general, 1-MCP only delayed the onset of ripening related changes and did not significantly alter final values for the measures of firmness, colour, lycopene and chlorophyll content, and polygalacturonase activity of tomato stored at a lower temperature (Mostofi *et al*. 2003). Mathur and Srivastava (2005) reported that 1-MCP treatment inhibited ethylene evolution and malic enzyme activity for upto 8 days in mango and delayed ripening under Indian conditions. The objective of the present study was to investigate the effect of 1-MCP treatment on ripening associated changes in two differentially ripening varieties of tomato and to see its

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effectiveness under a relatively higher storage temperature that normally prevails in the tropics.

MATERIALS AND METHODS

Tomato (*Lycopersicon esculentum* Mill.) varieties Pusa Ruby and Pusa Gaurav, which differ in their ripening behaviour, were selected for the study. Pusa Ruby is a thin skinned, early ripening variety, which enjoys consumer preference. Pusa Gaurav on the other hand is a thick-skinned, late ripening type, which is preferred by the processing industry. These varieties were grown in the field following recommended cultivation practices. Mature green tomatoes were harvested and used for further experiments.

Mature green unripe fruits were wiped clean and placed in airtight containers of 2.5 litre capacity to expose them to 1-MCP evolved from ethylbloc. The fruits were treated with different concentrations of 1-MCP (1µl/l and 5µl/l) for four hours using required amounts of ethylbloc, keeping it airtight. After the treatment duration, the fruits were transferred to well aerated labeled baskets and stored at room temperature (28±2°C) until the fruits reached full ripe stage. Days taken to attain full ripe stage in control and treatments were recorded. Sampling was done at mature green (just before treatment), half ripe and full ripe stages. Respiration rate was measured on alternate days using respirometer based on Infra Red Gas Analyser. Chlorophyll and carotenoids were extracted in DMSO and absorbance recorded at 663, 645, and 480nm using spectrophotometer (Hiscox and Israelstam 1979). The amount of carotenoids was calculated based on the formula given by Venkatarayappa (1984). Lycopene was extracted in acetone and absorbance recorded at 503 nm following Mencarelli and saltveit (1988). Polygalacturonase activity expressed as mg glucose equivalent/hr/g fr.wt. in the pericarp of tomato fruits was measured following Lazan *et al*. (1990). There were three replications for each observation. The data was analyzed statistically by analysis of variance.

RESULTS AND DISCUSSION

The present study was taken up to investigate the effect of two concentrations of 1-MCP treatment on ripening of tomato fruits and to see whether it is effective at a relatively higher storage temperature that prevails in the tropics. The two varieties selected for the study differed significantly in duration of ripening. However, both varieties showed similar response towards 1-MCP treatment (Plate 1). 1-MCP (1µl/l and 5µl/l) treatment for 4 hrs were found to be most effective compared to

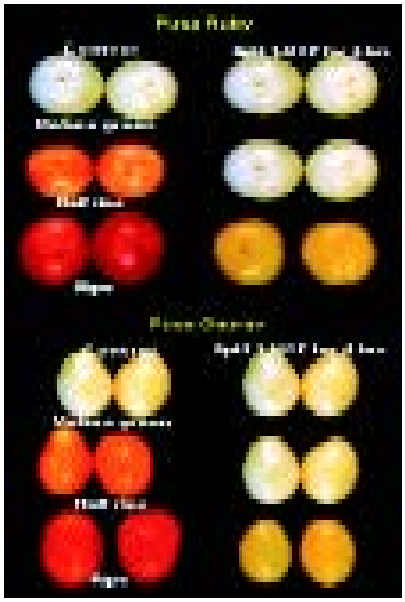

Plate 1. Effect of 1-MCP treatment on shelf life of tomato fruits

lower treatment durations (Pushpalata 2003). Probably, at very low concentrations, the duration of treatment is more important and a still longer duration could be more effective. Wills and Ku (2002), and Mostofi *et al*. (2003) reported that 1-MCP induced delay in ripening depended

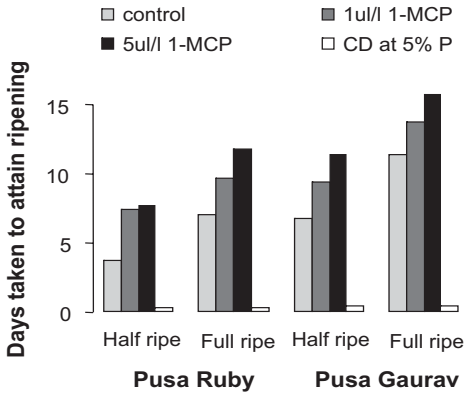

Fig.1. Days taken by control and 1-MCP treated tomato fruits to attain ripening

on concentration, exposure duration and storage temperature. In the present study, attainment of full ripe stage in both the varieties was delayed by 4 days, which amounted to 60% in Pusa ruby and 36% in Pusa Gaurav. This was observed in the treatment 5µl/l of 1-MCP (Fig. 1).

The respiration rate measured on alternate days showed a peak at 3 days after treatment in control untreated fruits of both the varieties. However, the two varieties responded differently to the treatment in delaying the peak rate. While 5µ/l 1-MCP delayed the peak upto 7th day in Pusa Ruby (Fig. 2A), it showed a peak on 5th day in Pusa Gaurav. In the latter variety, 1µl/l treatment was most effective (Fig. 2B). Abdel-Rahman (1997) also observed that the respiration rate of young developing fruits remain low until mature green stage, then increase sharply and decline afterwards. The respiratory climacteric is closely linked with ethylene and 1-MCP is an inhibitor of ethylene response. This might have led to the delay in respiratory peak under 1-MCP treatment in the present study.

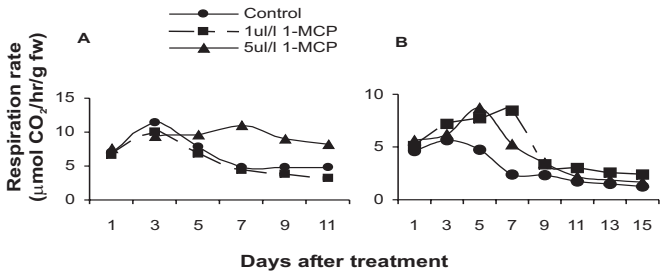

Fig.2. Respiration rate of control and 1-MCP treated whole tomato fruits of Pusa Ruby (A) and Pusa Gaurav (B).

1-MCP treatment delayed the loss in chlorophyll in both the varieties compared to control untreated fruits (Fig. 3). Unlike Pusa Gaurav, 1-MCP (1µl/l) proved to be more effective in Pusa Ruby. However, at ripe stage, the chlorophyll content of both treated and untreated fruits were comparable in both the varieties. Between the two varieties, Pusa Ruby had higher chlorophyll content at all stages and treatments when compared to Pusa Gaurav. This could be due to the light coloured nature of the late ripening Pusa Gaurav. However, Pusa Gaurav accumulated more carotenoids. As the ripening advanced, carotenoid content also increased (Fig. 4). In both the varieties, 1-MCP treatment significantly

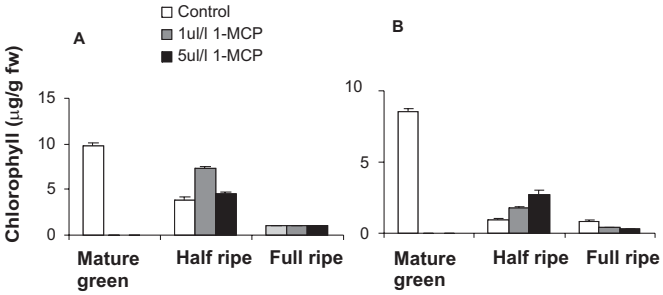

Fig.3. Total chlorophyll content in pericarp tissues of control and 1-MCP treated tomato fruits at mature green (MG), half ripe (HR) and full ripe (FR) stages of Pusa Ruby (A) and Pusa Gaurav (B).

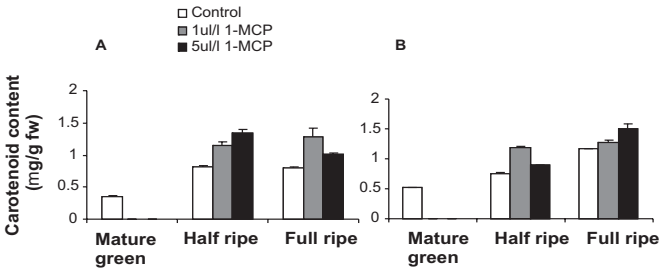

Fig.4. Carotenoid content in pericarp tissues of control and 1-MCP treated tomato fruits at mature green (MG), half ripe (HR) and full ripe (FR) stages of Pusa Ruby (A) and Pusa Gaurav (B).

increased the total carotenoid content at half ripe as well as full ripe stages. The two varieties responded differentially to 1-MCP concentration in terms of carotenoid content. Pusa Gaurav accumulated more of total carotenoids, Pusa Ruby accumulated around four-fold higher lycopene. Till half ripe stage, lycopene increased slowly and thereafter it registered six-fold increase in Pusa Ruby and four fold increase in Pusa Gaurav, by full ripe stage (Fig. 5). Interestingly, both the

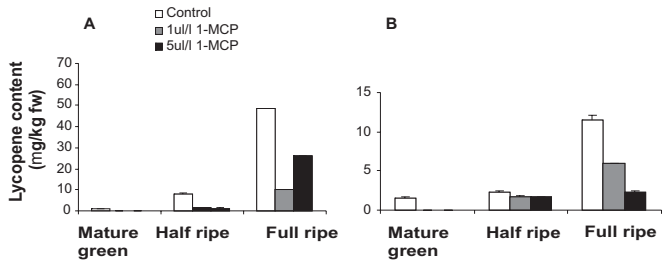

Fig.5. Lycopene content in pericarp tissues of control and 1-MCP treated tomato fruits at mature green (MG), half ripe (HR) and full ripe (FR) stages of Pusa Ruby (A) and Pusa Gaurav (B).

concentrations of 1-MCP not only delayed lycopene accumulation, but also significantly affected its magnitude. The synthesis of lycopene depends upon ethylene action. In Pusa Ruby, ethylene production might be higher and it may induce the gene responsible for lycopene synthesis. The synthesis of other carotenoids might not be ethylene dependent (Marty *et al*. (2005), and 1-MCP could have indirect effect on carotenoid accumulation. Polygalacturonase activity was negatively affected by 1-MCP treatment (Fig. 6). However, at full ripe stage, the activities of the treated fruits were comparable or higher than that of control. This indicated that polygalacturonase activity in 1-MCP treated fruits was not limiting to the softening process at red ripe stage. Moreover, reduced PG activity at half ripe stage helps in maintaining the firmness till optimum colour develops. If the fruit softens before it develops optimum colour, the chance of damage during handling is more (Mostofi *et al*. 2003).

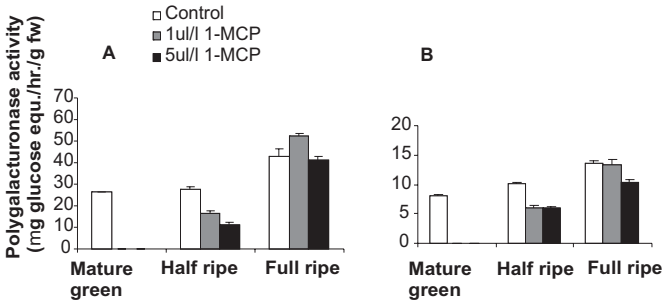

Fig.6. Polygalacturonase activity in pericarp tissues of control and 1-MCP treated tomato fruits at mature green (MG), half ripe (HR) and full ripe (FR) stages of Pusa Ruby (A) and Pusa Gaurav (B).

The present study conducted at higher temperature (28± 2°C) showed that 1-MCP treatment significantly delayed the ripening process in both the varieties. Study on the synthesis of lycopene and carotenoids in light of ethylene action would give more insight into the mechanism of 1-MCP action.

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