ISSN: 0974 - 0376

The Ecoscan : Special issue, Vol. IX: 161-165: 2016
AN INTERNATIONAL QUARTERLY JOURNAL OF ENVIRONMENTAL SCIENCES
www.theecoscan.com

INFLUENCE OF 1-METHYL CYCLOPROPENE (1-MCP) ON THE SHELF LIFE AND QUALITY OF BANANA CV. GRAND NAINE UNDER AMBIENT CONDITIONS

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KEYWORDS

Quality of Banana
Ambient Conditions
1-Methyl Cyclopropene
Staple fruit

**Proceedings of National Conference on
Harmony with Nature in Context of
Resource Conservation and Climate Change**
(HARMONY - 2016)
October 22 - 24, 2016, Hazaribag,
organized by
Department of Zoology, Botany, Biotechnology & Geology
Vinoba Bhave University,
Hazaribag (Jharkhand) 825301
in association with
National Environmentalists Association, India
www.neaindia.org

The Ecoscan
AN INTERNATIONAL QUARTERLY JOURNAL OF ENVIRONMENTAL SCIENCES

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ABSTRACT

An experiment was conducted to study the effect of 1-Methylcyclopropene (1-MCP) on storage of Banana cv. Grand naine at Post Harvest Technology Laboratory, HC and RI, Dr. Y.S.R.H.U, Venkataramannagudem in the year 2013-14 to evaluate the post harvest shelf life and quality parameters during storage of banana. Mature fruits of banana cv. Grand Naine were treated with 1-Methylcyclo propene at three concentrations (250 ppb, 500 ppb and 750 ppb) and three durations of exposure (6 h, 12 h and 24 h).Total nine treatment combinations(T_1:250ppb,6h; T_2:250 ppb,12h;T_3:250ppb, 24h; T_4:500 ppb,6h; T_5:500ppb,12h; T_6:500ppb, 24h; T_7:750 ppb, 6h; T_8:750ppb,12h; T_9:750 ppb, 24h) were taken along with one control (without treatment) and their effect on shelf life and quality parameters was studied under ambient ($27^oC \pm 2$) conditions. T_9 was found to be effective in maintaining the peel colour (stage 3), firmness (8.75) with low TSS(16.41) and titrable acidity(0.15%), high ascorbic acid content(12.15mg) and shelf life (30.53d) of banana cv. Grand Naine under ambient conditions. The effectiveness of 1-MCP increased with increase in the concentration and duration of exposure.

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INTRODUCTION

Banana (*Musa* spp.) is considered as staple fruit worldwide because it is easily grown, nutritious, cheap source of energy and vitamins, easy to peel, most edible everyday fruit relished from cradle to grave. Banana occupies fifth place in world trade. World's production of banana is 1020.28 lakh tonnes which occupies first place in overall fruit production. India ranks first in banana production with 297.8 lakh tonnes, which shares 29% of world's production (APEDA, 2010).

The export potential of banana from India is 45 thousand metric tonnes from Maharashtra, Gujarat, Tamilnadu, Andhra Pradesh and Karnataka (APEDA, 2010). Owing to its significance in exports, there is a need to concentrate on improving the shelf life and quality of banana. To achieve successful export, the harvested bananas are subjected to ethylene treatments in ripening chambers on commercial scale (NHB, 2011). But after taking out from the ripening chambers, their shelf life is only 3-5 days and quality depends upon various factors like conditions of treatment, temperature etc. With the increase in temperature, the respiration and ethylene evolution rates (Pesis, 2004) also increase. Tropical countries like India need to take further care to curtail the ripening process to enhance the shelf life, to improve quality and achieve successful exports. This aspect has great economical significance for distributors, exporters and supermarkets.

India being a developing country, there is a need for a non-sophisticated technology for extension of postharvest shelf life and maintaining the quality at ambient temperature. Such non-expensive technology is postharvest treatment of fruits with 1-MCP, a non-toxic gaseous product that has been used as a tool to extend postharvest life, delay softening and to improve post storage quality of different climacteric fruits (Serek *et al*. 1994).

1-Methylcyclopropene (1-MCP) has been reported to inhibit the effect of both endogenous and exogenous ethylene action in climacteric fruits and prolong the shelf life by delaying ripening (Sisler and Serek, 1997, Sisler and Blankenship, 2003). This technique is not available to banana farmers and traders because the studies on its efficacy have not been carried out under local conditions despite its use being approved in other countries. Experiments conducted on banana showed varied responses and did not provide consistent recommendations for commercial application of 1-MCP to extend the shelf life of banana. Hence more precise studies are needed to arrive at a definitive conclusion about the application of 1-MCP in banana.

Thus considering the losses incurred and lack of information on postharvest handling of banana, the efficacy of this tool was tested on quality and shelf life of tissue cultured Grand Naine banana fruits under ambient conditions which has not been hitherto tested under tropical conditions in Andhra Pradesh.

MATERIALS AND METHODS

The study was carried out during 2013-14 at Post Harvest Technology laboratory, Horticultural College and Research Institute, Dr. Y.S.R.Horticultural University,

Venkataramannagudem, West Godavari district of Andhra Pradesh. Hands of mature green bananas (*Musa* AAA Grand Naine) were obtained from Amruth Banana Ripening Industry, Kedareswarapet Fruit Market, Vijayawada. The fruits were sorted for freedom from the visual defects and uniformity in weight and shape. Six hands, each containing 6-8 fingers per hand, were used in each replication.

1-MCP was obtained from Ansip-F® of Lytone Enterprises Inc. (Taiwan, R.O.C) in tablets form of 1.1g each containing 0.009% active ingredient by weight.

Unblemished, uniform sized, mature green fruits of banana cv. Grand naine were obtained and washed thoroughly. Then the fruits were treated with Bavistin @ 0.1 % and dried under shade. Six hands each containing 6-8 fruits were then placed in 23L carton box. Three replicates of each treatment along with control were arranged in this way. The required quantity of 1-MCP Ansip-F tablets for 23L carton for yielding 250 ppb, 500 ppb and 750 ppb were calculated. The 1-MCP powder was placed inside the flask containing a rubber septum. Then warm distilled water (at 40-50^{0}C) was added to the flask for dissolving the 1-MCP powder. The flask was then placed inside the container through the top opening and the flask lid is removed immediately before the carton box was completely sealed. After exposure to a specified time of 6 h, 12 h and 24 h, the carton box was opened and the fruits were stored. This modified method was described by Orathai Wongmetha and Lih-Shang Ke (2012) and Alves *et al.* (2004). The fruits were used for analysis of various physico chemical parameters at successive intervals. Total nine treatment combinations with 1-MCP concentrations 250 ppb, 500 ppb and 750 ppb and 6, 12 and 24 hours of exposure were taken up along with a control (untreated) treatment.

The peel colour of the fruits was determined by visual observation and expressed in terms of percentage according to the colour score as given in banana ripeness chart of Loesecke (1950). A table top Penetrometer (Model-FT-327, EFFEGI, Made in Italy) with a spherical 1.1cm diameter plunger was used to record the firmness of the fruits. The total soluble solids were determined by using Hand Refractometer and expressed as ^{0}Brix (Ranganna, 1986). The Titrable acidity and Ascorbic acid were determined by the process given by Ranganna, 1986.

The data was statistically analyzed in a Completely Randomized Design (CRD) with factorial concept as per the procedure outlined by Panse and Sukhatme (1985).

RESULTS AND DISCUSSION

Peel colour

Rapid change in peel colour was observed in control fruits which reached stage 6 (full yellow colour) on the 18th day of storage while those treated with 1-MCP reached stage 3 (light yellow colour) to stage 5 (yellow with green tip). T_9 recorded lowest peel colour stage 3(light yellow colour) which was on par with T_8. This might be due to degradation of chlorophyll followed by unmasking of carotenoids that resulted in an increase in the orange and yellow pigments in the peel and also due to high respiration rate during ripening of fruits. 1-MCP retards the synthesis of ethylene as reported by Jiang and Joyce (2000), Blankenship and Dole (2003) and Huber *et al.* (2003) and hence the ethylene action, photochemical efficiency and decline in green skin coloration are prevented. This might be the reason for delay in change in peel colour in 1-MCP treated fruits. Similar result was obtained by Mandal *et al*. (2016) where banana showed delayed peel colour development at post harvest storage.

Fruit firmness

Bananas kept under control lost firmness faster than all other treatments tested with 11.09 on 3rd day to 4.09 on 21st day. The 1-MCP treated fruits retained their firmness for longer period and T_9 was the best among the treatments with12.53 on the 3rd day to 5.63 on the 21st day. This might be due to a change in cell wall components and starch degradation. The starch granules, packed in the tissue of banana flesh give rise to toughness of the unripe fruit and when hydrolyzed to sugar, there will be an increase in cell wall solubility and the fruit firmness decreases as reported by Seymour (1993) in banana. The firmness was retained for longer period during storage in 1-MCP treated fruits due to inhibition of ethylene binding with its receptors by 1-MCP that delayed changes in cell wall components and starch degradation. The results are in harmony with the earlier findings of Golding *et al.*, 1998, Giovinni and Golding (2007), Phebe ding *et al.*, 2009, Kesta (2010) in banana.

Total soluble solids

Fruits under control showed a faster increment in TSS content, ranging from 8.45 ^{o}Brix on 3rd day to 24.23 ^{o}Brix on 12th day

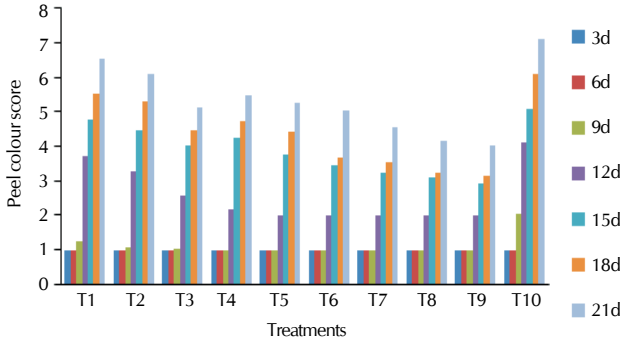

Figure 1: Effect of 1-Methylcyclopropene on peel colour of banana cv. Grand Naine under ambient conditions

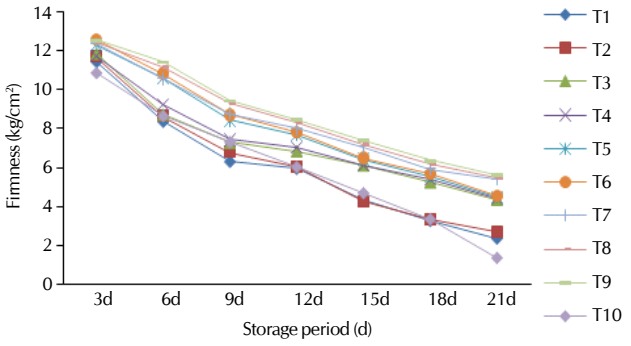

Figure 2: Effect of 1-Methylcyclopropene on firmness (kg/cm²) of banana cv. Grand Naine under ambient conditions

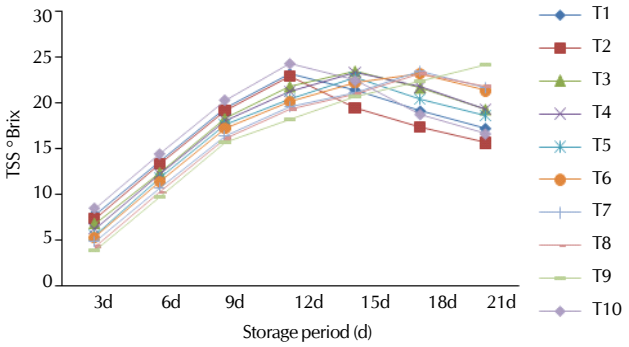

Figure 3: Effect of 1-Methylcyclopropene on total soluble solids (°Brix) of banana cv. Grand Naine under ambient conditions

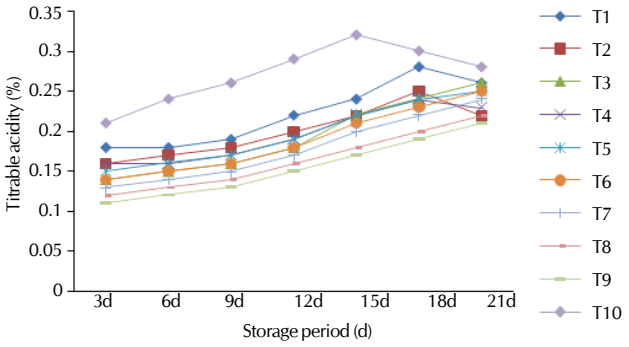

Figure 4: Effect of 1-Methylcyclopropene on titrable acidity (%) of banana cv. Grand Naine under ambient conditions

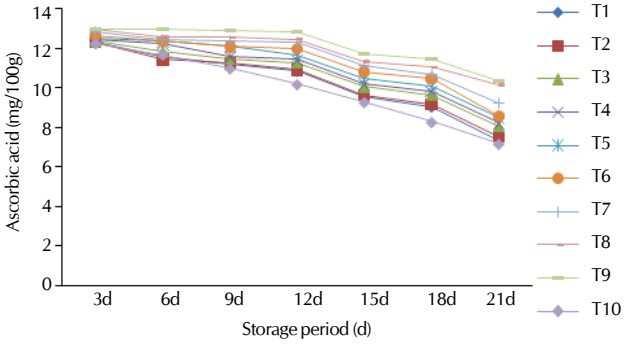

Figure 5: Effect of 1-Methylcyclopropene on ascorbic acid (mg/100g) of banana cv. Grand Naine under ambient conditions

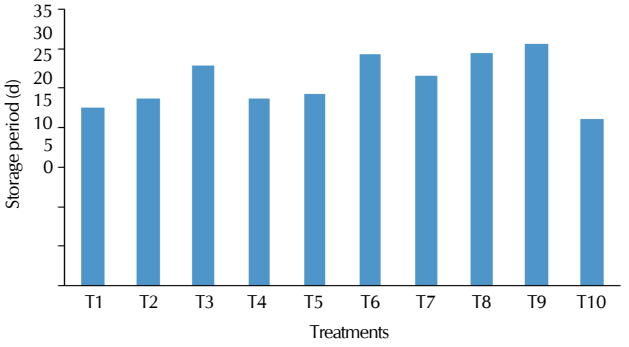

Figure 6: Effect of 1-Methylcyclopropene on shelf life of banana cv. Grand Naine under ambient conditions

of storage. Thereafter the TSS in control decreased gradually. On the other hand, fruits treated with 1-MCP slowly reached their TSS peak, where fruits treated with 750 ppb for 24 h (T_9), initially recorded 3.92 ^{0}Brix on 3rd day and reached the peak value (24.2 ^{0}Brix) on 21st day of storage. This similar condition of maximum TSS in control and minimum TSS in treated banana was reported by Mandal *et al*. (2016). The low TSS values in 1-MCP treated fruits could be due to slow down of ripening as a result of binding of 1-MCP with ethylene receptor that resulted in an apparent delay in the onset of elevated ethylene evolution and respiration rates and also delay in several physiological responses related to ripening thereby extending the shelf life of fruits with better quality as reported by Zhou *et al*. (2004) and Golding *et al*. (2005) in banana. The results are in line with the reports of Zewter *et al*. (2012), Rahman *et al*. (2014) in banana.

Titrable acidity

Titrable acidity in control fruits increased with storage period and declined after 15th day when it reached the ripening stage. The pattern of increase and fall after reaching peak contents could be associated with ripening stages of the fruits which were influenced by the storage treatments as reported by Siriboon and Banlusilp (2004) in banana. The titrable acidity slowly increased in 1-MCP treated fruits which might be due to delay in respiration process thereby delaying the conversion of organic acids into sugars. As 1-MCP delays the ripening process, so it delayed the increase in the Titrable acidity too. T_9 showed a much delay in the rise in titrable acidity.

Ascorbic acid

Fruits in control showed a faster decrease in ascorbic acid content *i.e* 12.2 on 3rd day to 7.15 on 21st day than the 1-MCP treated ones. T_9 recorded the highest value12.96 on 3rd day and 10.33 on 21st day. This might be due to the activity of the oxidizing enzymes like ascorbic acid oxidase, peroxidase and catalase which convert the ascorbic acid to dehydro ascorbic acid as reported by Mapson (1970), Shanmugavelu *et al*. (1976) in sapota. The ascorbic acid decreased gradually from 3rd day (12.53) to 21st day (8.49) of storage which could be attributed to slow increase in the activity of oxidizing enzymes as ripening stage advances where it is converted to de-hydro ascorbic acid. The 1-MCP treated fruits maintained high ascorbic acid levels even at the end of the storage period which might be due to delay in ripening related processes and also slow down of the activities of the oxidizing enzymes. Gayathri and Satyanarayana (2016) also reported that there was a slow decline in ascorbic acid when minimal processed jack fruit bulbs were placed in refrigerated conditions.

Shelf life

The highest shelf life (30.53 d) was recorded by T_9 (1-MCP at 750 ppb for 24 h) lowest shelf life (21.1 d) was recorded in control. Shelf life in banana is influenced by transpiration, respiration and ethylene evolution rates, which in turn depend upon storage conditions like temperature, relative humidity and gaseous exchange in the storage environment. 1-MCP inhibits ethylene action by inhibiting ethylene binding with its receptors initially in the treated samples and again ethylene

action is restored after formation of new receptor sites. Thus the biochemical changes associated with ethylene response are delayed. This is why the untreated fruits lost their shelf life earlier than the treated fruits as reported by Sisler *et al*. (1999), Golding *et al*. (1998).

ACKNOWLEDGEMENT

The authors acknowledge Horticulture College and Research Institute, Venkataramannagudem, West Godavari dt. Andhra Pradesh, for providing laboratory facilities to conduct this experiment.

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