Gezira j. agric. sci. 1 (2): 59-72 (2003)

Effect of maleic hydrazide and waxing on ripening and quality of tomato fruit

Ikhlas H. Ahmed and Abu-Bakr A. Abu-Goukh
Department of Horticulture, Faculty of Agriculture, University of Khartoum, Shambat, Sudan.

ABSTRACT

The effect of postharvest treatment of maleic hydrazide (MH) and waxing on ripening and quality of 'Stain-B' and 'UC-82' tomato fruits at 20 ± IOC and 85-90% RH was evaluated during 2002/2003 season. Maleic hydrazide at 100, 250 and 500 ppm delayed fruit ripening by one to three days in both tomato cultivars. The higher the concentration; the more the delay in fruit ripening. Waxing in addition to MH treatment resulted in 1-2 days more delay in fruit ripening, compared to MH treatment alone. The effect of MH treatment and waxing in delaying fruit ripening was in retarded respiratory climacteric, delayed colour development and total soluble solids (TSS) accumulation, decreased fruit softening, titratable acidity, phenolic content and weight loss, and retained ascorbic acid content

INTRODUCTION

Tomato (Lycopersicon esculentum Mill.) is one of the most important vegetable crops in the Sudan and is grown commercially in every state in the country. Its annual production in 2000 was 65300 tons, representing 40% of total vegetable production in the country (AOAD, 2001). Tomato is a winter crop in the Sudan and is harvested during the summer (March—April) which is characterized by high temperature and low relative humidity. These conditions generally result in excessive water loss, faster ripening and greater deterioration of the produce.

Maleic hydrazide (MH) is known as a growth regulator that inhibits some processes in fruits and vegetables. Several workers
MH inhibited sprouting and reduced storage losses of potato and onion during storage (Meister, 1984). The effect MH on the ripening process varies with different types of fruits. It delayed fruit ripening in mangoes (Krishnamurthy and Subramanyam, 1970) and

tomatoes (Southwick and Lachman, 1953). Maleic hydrazide applied on sapota fruits, however, hastened the ripening process (Lakshiminarayana and Subramanyam, 1967).

Waxing significantly reduces the permeability of the skin to gases. The commodity, through respiration, reduces oxygen and increases dioxide and a modified atmospheric condition which is beneficial to the commodity may be achieved (Kader et al., 1985). Waxing was reported to delay fruit ripening, reduce water loss and extend shelf-life (Castrillo and Bermudez, 1992).

This study was carried out to evaluate the effect of maleic hydrazide and waxing on ripening and quality of tomato fruit.

MATERIALS AND METHODS

Mature green tomato fruits of 'Strain-B' and 'UC-82' were harve-Sted from the Demonstration Farm of the Faculty of Agriculture, University of Khartoum, Shambat (150 40"N, 320 22"E) during 2002/ 2003 season. Fruits were selected for uniformity of size, maturity and freedom from blemishes. Fruits were washed, dried and transported in plastic baskets to the ripening rooms.

The fruits of each cultivar were distributed among six treatments in a completely randomized design, with four replications. The treatments included: 0, 100,250 and 500 ppm MH without waxing and 250 and 500 ppm with waxing. Maleic hydrazide treatments were applied by dipping the fruits for three minutes in maleic hydrazide (Citrashine N-IMZ "Deco-Pennwalt") solutions of 100, 250 and 500 ppm and air dried. Food-grade wax (Flucka AG, CH-9470 Buchs) was used for wax treatments. The wax was applied in a thin layer by brushing over the surface of the fruits. Untreated fruits (control) were dipped indistilled water and air dried. The fruits were ripened at 20±1 ^{o}c and 85- 90% relative humidity,

Respiration rate was determined in 20 fruits in each treatment by the total absorption method of Charlimers (1956). Colour changes were determined every other day during the ripening period in the same 20 fruits used for respiration rate determination. The colour score used: Mature-green = 0, breaker = 1, light-pink = 2, dark-pink = 3, table-ripe = 4 and canning-ripe = 5. Weight loss in fruits was determined in two days intervals according to the formula: W_I = [(W_o

$-W_t)/W_o]$ x 100; where W_i is the percentage weight loss, W_o is the initial weight of fruits and W_t is the weight of fruits at the designated time. Fruit firmness was determined in three fruits picked randomly from each treatment, other than those used for respiration rate and colour changes, in two-days intervals during the ripening period. Fruit firmness was measured by Magness and Taylor firmness tester (D-Ballautf Mega Co) equipped with an 8mm-diameter plunger tip. Two readings were taken from opposite sides of each fruit after the skin was removed.

Total soluble solids (TSS) were determined in two-day intervals in the same fruits used for determination of fruit firmness. TSS were determined directly from the fruit juice using Kruss hand refract-ometer (model HRN-32). Two readings were taken from each fruit and the mean values were calculated and corrected according to the refractometer chart. Titratable acidity was measured. Ascorbic acid was determined in fruit extract using the 2,6-dichlorophenol-indophenol titration method.

Analysis of variance procedure, followed by Fisher's protected LSD test with a siY1ificance level of $P< 0.05$ were performed on all the data.

RESULTS AND DISCUSSION

Since the curves of the two cultivars for the different parameters studied showed the same trend, only the curve for one cultivar will be presented at a time to reduce the number of curves.

Maleic hydrazide treatment delayed fruit ripening in both tomato cultivars, the higher the concentration the more the delay. Similar results were reported for tomato (Southwick and Lachman, 1953), mango (Krishnamurthy and Subramanyam, 1970) and banana (El Rayah et al., 1980).

The wax treatment resulted in more delay in tomato fruit ripening. Waxing was reported to delay fruit ripening, reduce water loss and extend shelf-life of tomato (Castroq and Valencia, 1973) and mango (Castrillo and Bermudez, 1992). This delay in fruit ripening was reflected in changes in respiration rate, peel colour, flesh firmness, TSS, water loss, titratable acidity and ascorbic acid content.

The two cultivars showed a climacteric peak at about 46 mg C02/kg/hr (Fig. l). Maleic hydrazide (MH) and wax treatments slightly decreased the climacteric peak in both cultivars. The untreated fruits reached the climacteric peak after eight days in both cultivars. Fruits treated with MH at 100, 250 and 500 ppm without waxing reached the climacteric peak at one, two and three days later, respect-tively, compared to the untreated fruits. This is in agreement with

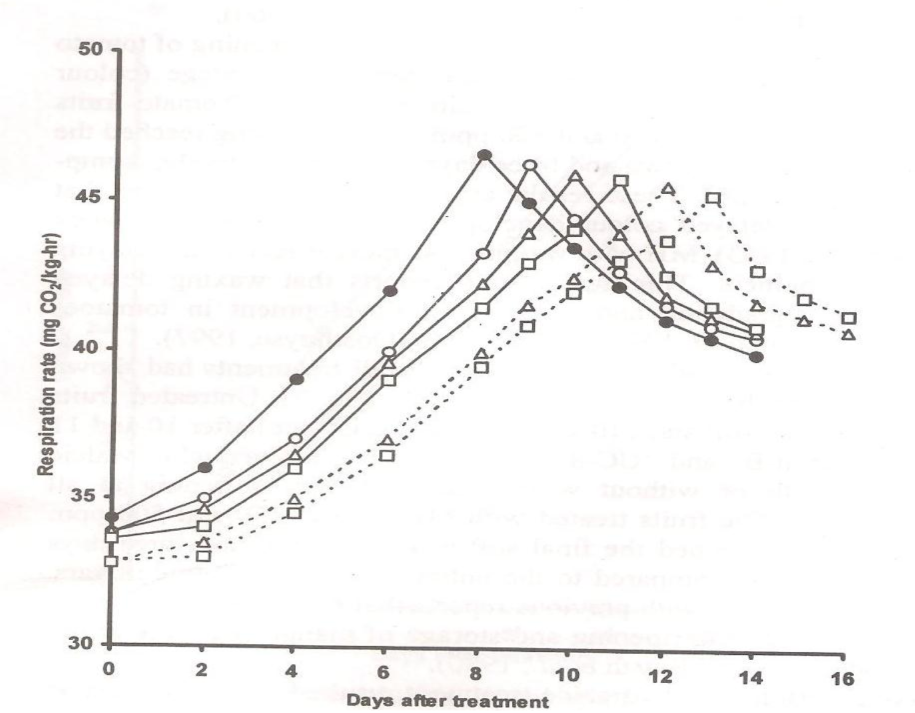

Fig. 1. Respiration rate during ripening of "Strain-B" tomato fruits treated with maleic hydrazide at 100 (○), 250 (Δ) and 500 ppm (□) without waxing (—) or with waxing (....), compared to untreated fruits (●) at 20± IC^{O} and 85-90% RH.

previous reports that MH delayed the onset of the climacteric in tomato (Southwick and Lachman, 1953) and in mango (Krishnam-urthy and Subramanyam, 1970). Tomato fruits treated with MH at 250 and 500 ppm with waxing reached the climacteric peak four and five days later, respectively, compared to the control. Similar results were reported for mangoes (Sadasivam et al., 1970) and oranges (Martinez et ale, 1991). Waxing has been shown to influence respiration rate by decreasing oxygen and increasing carbon dioxide content in the internal atmosphere of the fruit (Irving and Warren, 1960).

Skin colour score progressively increased during ripening of tomato fruits. The untreated fruits reached the canning-ripe stage (colour score 5) in 10 days in both tomato cultivars (Fig. 2). Tomato fruits treated with MH at 100, 250 and 500 ppm without waxing reached the canning-ripe stage one, two and three days later, respectively, comp-ared to the control. These results are in line with the findings that MH treatment delayed colour development in tomatoes (Southwick and Lachman, 1953). MH with waxing was more effective in delaying colour development. This agrees with reports that waxing delayed chlorophyll degradation and skin colour development in tomatoes (Castorq and Valencia, 1973) and mangoes (Oosthuyse, 1997).

During ripening, both tomato cultivars in all treatments had shown a continuous decline in fruit flesh firmness (Fig. 3). Untreated fruits reached the final soft stage (0 kg/cm2 shear resistance) after 10 and 11 days in 'Strain-B' and 'UC-82' tomato fruits, respectively. Maleic hydrazide, with or without waxing delayed fruit softening at all concentrations. The fruits treated with MH at 100, 250 and 500 ppm without waxing reached the final soft stage one, two and three days later, respectively, compared to the untreated fruits in both cultivars. This is in agreement with previous reports that MH treatment delayed fruit softening during ripening and storage of mango (Kaushik et al., 1991) and banana (El Rayah et al., 1980).

Waxing with maleic hydrazide treatment resulted in two more days delay in fruit softening in both cultivars, compared to MH treatment alone (Fig. 3). Wax treatment delayed fruit softening in tomatoes (Castroq and Valencia, 1973), mangoes (Sadasivam et ale, 1970), and oranges (Martinez et al., 1991).

Weight loss progressively increased during ripening of the two tomato cultivars in all treatments (Fig. 4). MH with or without waxing reduced weight loss at all concentrations. The higher the concentration, the more reduction in weight loss (Fig. 4). At the end of the ripening period, weight loss was 13.5% and 14.0% in the untreated tomatoes of 'Strain-B' and 'UC-82' cultivars, respectively. Weight loss was reduced by an average of 4.8%, 8.4% and 12.4% in the fruits treated with 100, 250 and 500 ppm MH without waxing, respectively, compared to the untreated fruits. Messier and Ashley (1981) reported that MH reduced weight loss in tomatoes.

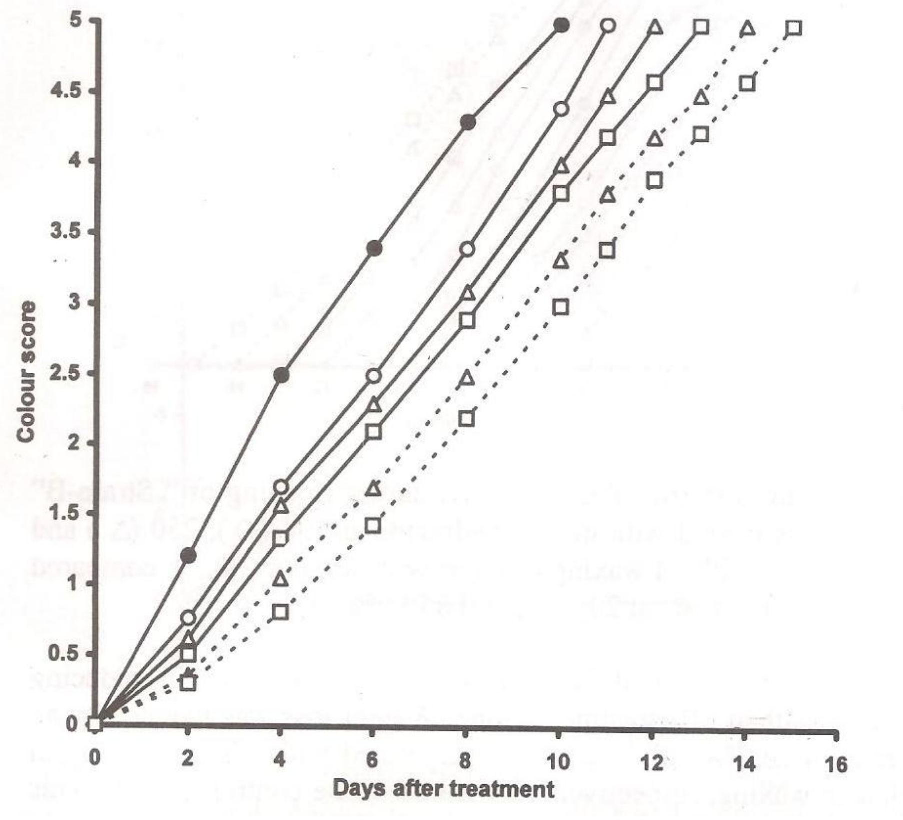

Fig. 2. Colour changes during ripening of "UC-82" tomato fruits treated with maleic hydrazide at 100 (○), 250 (Δ) and 500 ppm (□) without waxing(__) or with waxing (…….) compared to untreated fruits (●) at 20± IC^{O} and 85-90% RH.

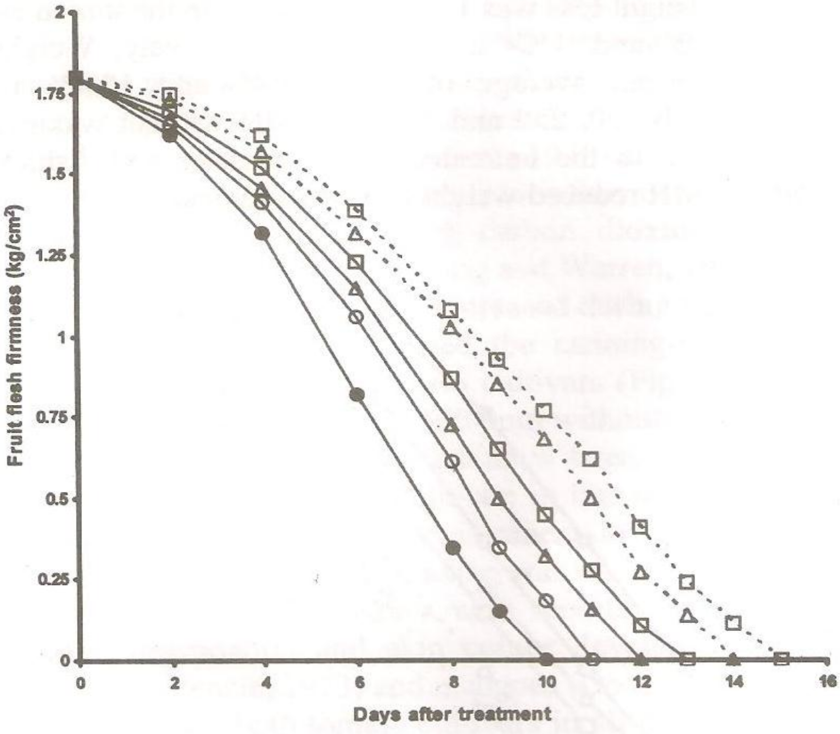

Fig. 3. Changes in fruit flesh firmness during ripening of " Strain-B" tomato fruits treated with maleic hydrazide at 100 (O), 250 (Δ) and 500 ppm (□) without waxing (—) or with waxing (……), compared to untreated fruits (●) at 20± I^{O}C and 85-90% RH.

Maleic hydrazide with waxing was more effective in reducing weight loss than MH treatment alone. Weight loss was reduced by an average of 23.3% and 29.2% in fruits treated with 250 and 500 ppm MH with waxing, respectively, compared to the control (Fig. 4). This is consistent with the reports that waxing decreased water loss in tomatoes (Castroq and Valencia, 1973), mangoes (Castrillo and Bermudez, 1992) and oranges (Martinez et ale, 1991).

Total soluble solids (TSS) showed continuous increase during ripening of both tomato cultivars. The maximum TSS value reached by the untreated fruits was 6.9% in 'Strain-B' and 7.5% in 'UC-82' (Fig. 5). These values were reached after 11 days in the untreated fruits of both cultivars. MH treated fruits reached the maximum TSS value, one to three days and four to five days later, without waxing and with waxing, respectively, compared to the untreated fruits. MH was reported to decrease TSS during ripening of banana (El Rayah et al., 1980). The wax treatment added to the delay of ripening and accumulation of TSS. Waxing decreased TSS during ripening of mango (Oosthuyse, 1997) and orange (Martinez et al, 1991).

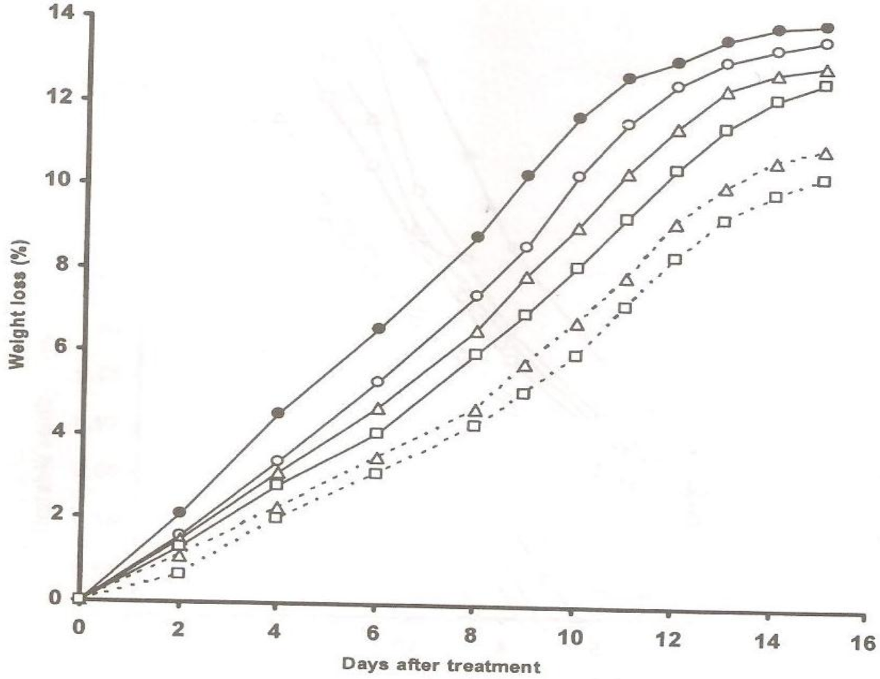

Fig. 4. Changes in weight loss during ripening of "UC-82" tomato fruits treated with maleic hydrazide at 100 (○), 250 (Δ) and 500 ppm (□) without waxing (—) or with waxing (….) compared to untreated fruits (●) at 20±1 co and 85-90% RH.

During ripening, both tomato cultivars had shown an increase in titratable acidity in all treatments reaching a peak shortly after the breaker stage (colour score 1.4 in 'Strain-B' and 1.2 in 'UC-82') and progressively decreased afterwards (Fig. 6). The minimum value of acidity was reached after eight days in the untreated fruits of both cultivars. MH treated fruits reached the minimum value of titratable acidity one to three days, and four to five days later, without waxing and with waxing, respectively, compared to the untreated fruits in both cultivars. This is in agreement with previous reports that waxing decreased acidity during storage of mangoes (Oosthuyse, 1997) and oranges (Martinez et ale, 1991).

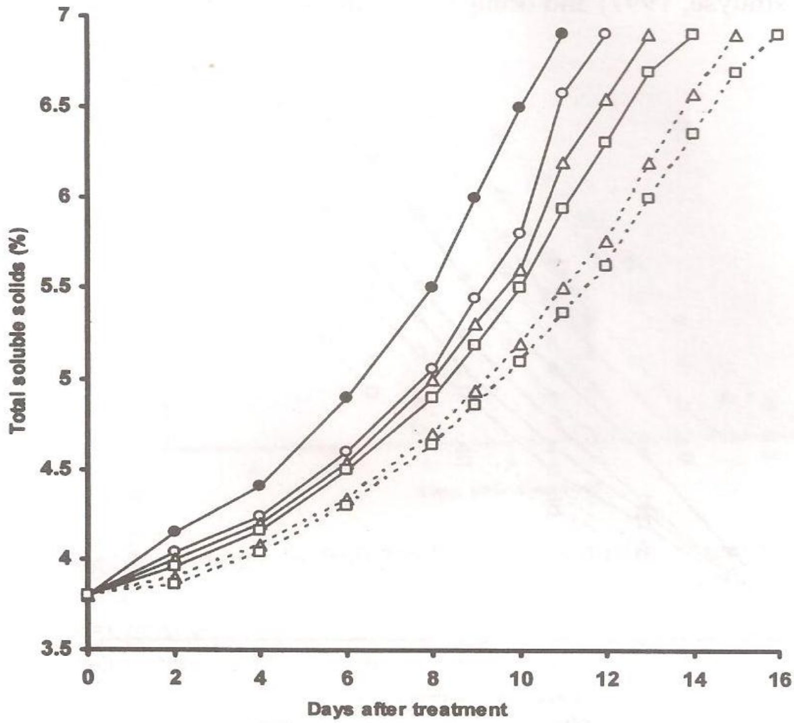

Fig. 5. Changes in total soluble solids during ripening of "Strain-B" tomato fruits treated with maleic hydrazide at 100 (○), 250 (Δ) and 500 ppm (□) without waxing (——) or with waxing (…...), compared to untreated fruits (●) at 20±1C^0 and 85-90% RH.

During ripening, ascorbic acid (AA) content increased up to the table-ripe stage (colour score 4) and then decreased in all treatments in both cultivars (Fig. 7). Ascorbic acid retained at the end of the ripening period was 20.5 and 21.4 mg/100g fresh weight in the untreated fruits of 'Strain-B' and 'UC-82', respectively. Maleic hydrazide, with or without waxing, resulted in higher AA retention, the higher the concentration the more AA retention. At the end of the ripening period, AA retained was higher by an average of I .9%, 3.7% and 4.9% in fruits treated with 100, 250 and 500 ppm MH without waxing in both cultivars, respectively, compared to the control. MH delayed tomato fruit ripening in both cultivars and resulted in reduced AA losses.

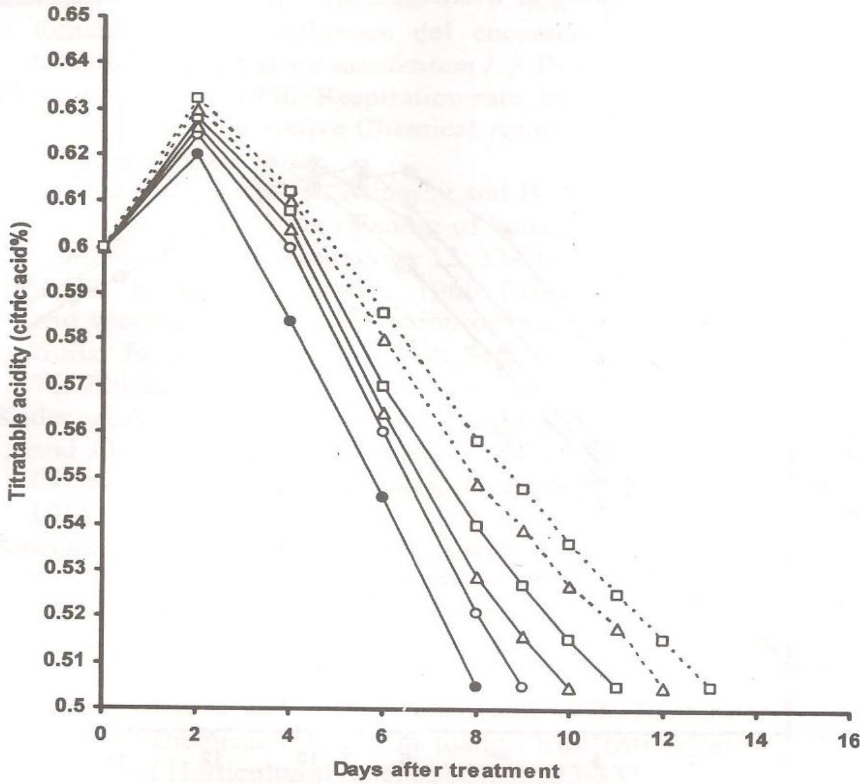

Fig. 6. Changes in titratable acidity during ripening of "UC-82" tomato fruits treated with maleic hydrazide at 100 (○), 250 (Δ) and

500 ppm (□) without waxing (——) or with waxing (........) compared to untreated fruits (●) at 20± IC^{O} and 85-90% RH.

Maleic hydrazide with waxing was more effective in retaining AA than MH treatment alone. Ascorbic acid retained at the end of ripening was increased by 6.4% and 8.0% in fruits treated with MH at 250 and 500 ppm with waxing, respectively, compared with the control (Fig. 7). Waxing has been shown to influence respiration rate by decreasing O_2 and increasing CO_2 content in the internal atmosphere of the fruit (Irving and Warren, 1960). It was reported that losses in AA could be reduced by storing apples in a reduced O_2 atmosphere (Seung and Kader, 2000).

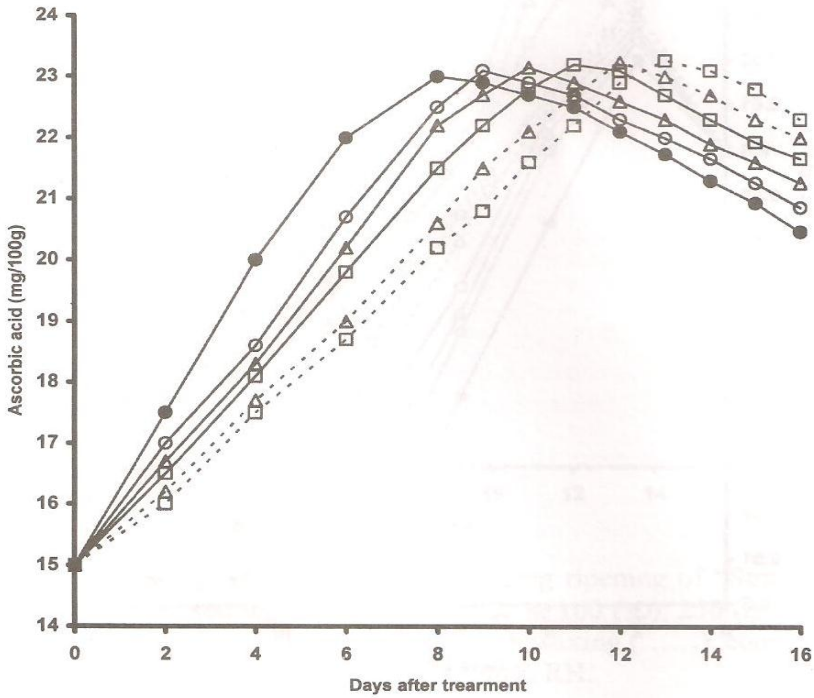

Fig. 7. Changes in ascorbic acid content during ripening of "Strain-B" tomato fruits treated with maleic hydrazide at 100 (○), 250 (Δ) and 500 ppm (□) without waxing (—) or with waxing (…...) compared to untreated fruits (●) at 20±IC^{O} and 85-90% RH.

REFERENCES

AOAD. 2001. Arab Agricultural Statistics Yearbook Vol. 21. Arab Organization of the Agricultural Development (AOAD). Dec. 2001. Khartoum, Sudan.

Castrillo, M. and A. Bermudez. 1992. Postharvest ripening in wax-coated "Bocado" mango. Journal of Food Science and Technology 27 (4): 457 – 463.

Castroq, G. and M. A. Valencia. 1973. The influence of waxing on tomato storage. [Influence del encerado enla conservation del tomato] (Lycopersicon esculentum L). Revista ICA 8(3): 311-327.

Charlimers, R. A. 1956. Respiration rate, pp 101-102. In: R.A. Charlimers (Ed.) Quantitative Chemical Analysis. Oliver and Boyd Ltd., Edinburgh and London.

El Rayah, A. He, A. F. A. Minessy and B. M. Hasan. 1980. Effect of Ethrel and MH on the ripening of banana fruits. Sudan Journal of Food Science and Technology 12: 53-56.

Irving, L. E. and A. L. Warren. 1960. Effect of temperature, washing and waxing on the composition of internal atmosphere of orange fruits. Journal of the American Society for Horticultural Science 76: 220-228.

Kader, A.A., R.E. Kasmire, F.G. Mitchell, M.S Reid, N.F. Sommer, and J,F. Thompson. 1985. Postharvest Technology of Horticultural Crops. Cooperative Extension, University of California, Davis, USA.

Kaushik, R. A., K. Ranjit and R. Kumar. 1991. Effect of postharvest application of 2,4,5-trichlophenoxy acetic acid, maleic hydrazide and calcium nitrate on the storage behaviour of "Dashehari" mango. Haryan Agricultural University Journal of Research 21: 287-291.

Krishnamurthy, S. and H. Subramanyam. 1970. Respiratory climacteric and chemical changes in mango fruit (Mangifera indica L.). Journal of Horticultural Science 95(3): 333-337.

Lakshiminaryana, S. and H. Subramanyam. 1967. Effect of preharvest spray of maleic hydrazide and isopropyl n-phenyl carbamate on sapota (Achras sapota L.). Journal of Food Science and Technology 4: 70-76.

Martinez, J. M., J. Cuquerella, M. D. Rio, M. Mateos and R. M. Ded. 1991. Coating treatment in postharvest behaviour of oranges, pp 70 79-83. In: Proceedings of the Conference of Technical Innovations in Freezing and Refrigeration of Fruits and Vegatables. Davis, Califomia, USA. 9-12 July 1989.

Meister, ROT. 1984. Maleic hydrazide (Royal MH-30) herbicide profile, pp 3-85. In: G.L. Beg, C. Sine, S. Meister and J. Paplyk (eds). The Farm Chemical Handbook. Miester Publishing Co. Willoughby OH, USA.

Messier, B. B. and R. A. Ashley. 1981. Effect of trifluralin, and [d] aminzide on tomato tolerance to Metribuzin. Proceedings of the North Eastern Science Society 35: 136-169.

Oosthuyse, S. A. 1997. Effect of waxing and number of waxes on weight loss, shelf-lifeand fruit quality of mangoes after four weeks of cool storage. Yea•book of South Africa Mango Growers Association 17: 105-110.

Sadasivam, R. S., J. S. Muthuswamy, S. Sudraraj and S. D. Daniel. 1970. Experiments with waxing of mango fruits in cornmon storage. Madras Agricultural Joumal 57(1): 194=199.

Seung, K. L and A. A. Kader. 2000. Preharvest and postharvest factors influencing vitamin C content of horticultural crops. Postharvest Biology and Technology 20:207-220.

Southwick, F. We and rW.H. Lachmanl 1953. The effect of maleic hydrazide and water on the rate of respiration of harvested tomato fruits. Proceedings of the American Society for Horticultural Science 61: 388-395.