EFFECT OF PREHARVEST CALCIUM CHLORIDE APPLICATION ON POSTHARVEST DISEASES AND SOME PHYSICO-CHEMICAL PARAMETERS OF TOMATO (CV 'RAJITHA')

R.Y. Wijerathne[1], W.A.M. Daundasekera[1*] and R. Peiris[2]

[1] *Department of Botany, Faculty of Science, University of Peradeniya*
[2] *Horticultural Crops Research and Development Institute, Gannoruwa*

Introduction

Tomato *(Lycopersicon esculentum*, Mill) is a soft fruit, which is prone to mechanical damage. Postharvest diseases (mainly fungal) also contribute significantly to postharvest losses. Preharvest application of 3% $CaCl_2$ on tomato fruit has shown to be effective in increasing the firmness index significantly (unpublished data). The present study reports the effects of preharvest calcium application on fruits on postharvest fungal diseases of tomato.

Materials and Methods

Isolation of postharvest fungal pathogens of tomato

Fungal pathogens were isolated onto potato dextrose agar (PDA) from the diseased tomato fruits (Meredith, 1968) collected from the market.

Ca^{2+} treatment

Tomato (cv 'Rajitha') was cultivated according to the specifications of the Department of Agriculture and randomly selected fruits at 7 days after full bloom stage were sprayed with 3% $CaCl_2$ (5 mL/ fruit). Fruits were harvested at turning stage (10% - 30% surface area turned to yellowish pink) for experiments.

Effect of Ca^{2+} treatment on fungal disease development

Disease development under natural conditions and artificial inoculation were investigated either on artificially wounded or unwounded fruits. For artificial inoculation, fruits were treated with 25 µL of conidial suspension (10^5 conidia/ mL). All the fruits were incubated in a moisture chamber and a visual estimate of the % area of disease development was done daily.

Effect of Ca^{2+} treatment on physico-chemical parameters

Soon after harvest, fruit firmness, total soluble solids content (TSS) and % titratable acidity (%TA) were measured. Firmness was measured with a hand-held penetrometer. The TSS was measured by refractometry and %TA was measured by titration (Wills and Ku, 2001).

Effect of Ca^{2+} treatment on disease resistance

Tomato peel extracts at turning and fully ripened stages were prepared by vacuum infiltration. Thin layer chromatography (TLC) combined with *Cladosporium* bioassay was employed to detect preformed antifungal activity in tomato peel tissues (Adikaram and Ratnayake Bandara, 1998).

Experimental design and data analysis

Six replicate fruits were employed for each treatment and the experiments were laid out according to Complete Randomized Design (CRD). Data were subjected to analysis by Analysis of Variance (ANOVA) using the Statistical Analysis Software (SAS) version 8.0 package. Mean separation was accomplished by least significant difference (LSD).

Results

Two postharvest fungal pathogens, *Aspergillus niger* and *Rhizopus stolonifer* were identified. Ca^{2+} treated fruits showed a lower disease incident than non-treated fruits (Table 1). This reduction of disease was significant with *R. stolonifer*. Wounded fruits exhibited the highest degree of disease irrespective of the Ca^{2+} treatment (Table 1).

Firmness and TSS were significantly higher and % TA is significantly lower in Ca^{2+} treated fruits compared with non-treated fruits (Table 2). In this tomato cultivar, the preformed antifungal activity decreased with preharvest spraying of Ca^{2+}. The antifungal activity increased with ripening (Table 3).

Table 1. Effect of Ca^{2+} treatment and wounding on fungal disease development (14 days after incubation).

Treatment	% area of disease development*		
	Natural	Artificial inoculation	
		A. niger	*R. stolonifer*
Ca^{2+} treated, wounded	49.67 Aa	57 Aa	11.5 Aa
Ca^{2+} treated, not wounded	5.5 Ab	2.17 Ab	1.83 Ab
Ca^{2+} not treated, wounded	73.33 Aa	58.33 Aa	27.5 Ba
Ca^{2+} not treated, not wounded	18.5 Ab	6.5 Ab	5.83 Bb

*Values in each column followed by different letters are significantly different at $p< 0.05$ level. Uppercase letters denote Ca^{2+} treatment effect and the lowercase letters denote wounding effects.

Table 2. Effect of preharvest Ca^{2+} treatment on postharvest physico-chemical parameters.

Treatment	Firmness (N)	% TA	TSS
Ca^{2+} treated	1.23 a	0.0380 a	5.00 a
Ca^{2+} not treated	1.02 b	0.0512 b	4.53 b

Values in each column followed by different letters are significantly different at $p< 0.05$ level.

Table 3. Area of antifungal activity in TLC bioassay of tomato (cv. 'Rajitha') peel tissues at different ripening stages.

Ripening stage of tomato	Area of inhibition zone (cm^2)*
Turning, Ca^{2+} treated	8.0 a
Turning, Ca^{2+} not treated	10.3 b
Ripe, Ca^{2+} treated	16.1 c
Ripe, Ca^{2+} not treated	21.7 d

*values followed by different letters are significantly different at $p< 0.05$ level.

Discussion and Conclusion

Ca^{2+} treatment has significantly lowered the disease development on tomato. This could largely be due to the increased firmness of fruit. Introduced Ca^{2+} has shown to entrap in the middle lamella thus increasing its stability and the elevated Ca^{2+} in tissues is reported to hinder the action of polygalacturonase enzyme, making the tissues more firmer (Doesburg, 1975). Artificial wounding may have facilitated the fungal growth through providing free passage and easy access to nutrients (Elad and Evensen, 1995). The increased TSS in Ca^{2+} treated fruit may be attributed to the accelerated α- amylase activity upon elevated Ca^{2+} levels in tissues (Marschner, 1986). The reason for the reduction of %TA upon Ca^{2+} treatment is not clear. Decreased preformed antifungal activity in Ca^{2+} treated fruit may probably be due to the antagonistic effect of Ca^{2+} on antifungal compounds in tissues (Huang *et al.*, 2002). In conclusion, it may be the increased firmness of the fruit (resulted from Ca^{2+} treatment), not the preformed antifungal compounds, that plays a major role during disease control.

References

Adikaram, N.K.B. and Rathnayake Bandara, B. M.(1998). Methodology for studying defense mechanisms against fungal pathogens: an overview. pp. 177-185. In: Disease resistance in fruits. (Eds) G.I. Johnson, E. Highly and D.C. Joyce. ACIAR Proceedings, No.80.

Doesburg, J.J. (1975). Relation between the solubilization of pectin and the fate of organic acids during maturation of apples. Journal of the Science of Food and Agriculture, 8: 206-216.

Elad, Y. and Evensen, K. (1995). Physiological aspects of resistance to *Botrytis cinerea.* Phytopathology, 85: 637-643.

Huang, R., Xiang, Y., Liu, X., Zhang, Y., Hu, Z. and Wang, D. (2002). Two novel antifungal peptides distinct with a five-disulfide motif from the bark of *Eucommia ulmoides* Oliv. FEBS Letters, 521(1): 87-90.

Marschner, H. (1986). Mineral Nutrition of Higher Plants, Academic Press, London, U.K.

Meredith, D.S. (1968). Freckle disease of banana in Hawaii caused by *Phyllostictina musarum* (cke.). Petr. Annals of Applied Biology, 62: 329-340.

Wills, R.B.H.and Ku, V.V.V. (2001). Use of 1-MCP to extend the ripening of green tomatoes and postharvest life of ripe tomatoes. Postharvest Biology and Technology, 26: 85-90.