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SILICON SUPPRESSES ANTHRACNOSE DISEASES IN TOMATO (*LYCOPERSICON ESCULENTUM*) BY ENHANCING DISEASE RESISTANCE

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INTRODUCTION

Tomato (*Lycopersicon esculentum* L.) is extensively cultivated in the world and is one of the most important vegetables grown in Sri Lanka. It is used as a major source of antioxidant lycopene, that reduces the risk of cancer by 40% and increases cancer survival.Tomato cultivation is expanding and modernizing with better productivity quality and regularity to meet the market demand, the main concern being the control of pests and diseases (Leite *et al.* 2001; Vivan *et al.* 2002).Tomato, being a highly perishable fruit/vegetable, is liable to mechanical injuries during the postharvest phases of handling chain where the high postharvest losses are recorded in Sri Lanka (EDB Statistics, 2006). Anthracnose disease (*Colletrotrichum gloeosporiodes*) is one of the major diseases of tomatoes causing both postharvest loss in quality and the quantity. The control of the diseases is achieved through chemical methods which is costly and environmentally unsound.

Current demand in sustainable crop production has increased interest for alternative solutions against diseases and pest problems. Numerous studies have shown that Si is effective in controlling diseases caused by both fungi and bacteria in different plant species. For example, Si increases rice resistance to leaf and neck blast, sheath blight, brown spot, leaf scald and stem rot (Datnoff and Rodrigues, 2005). Silicon also decreases the incidence of powdery mildew in cucumber, (Cherif *et al.*, 1994 Menzies *et al.*, 1991) barley and wheat (Belanger *et al.*, 2003; ring spot in sugarcane; rust in cowpea; leaf spot in Bermuda grass (Cynodon dactylon)and gray leaf spot in St. Augustine grass and perennial ryegrass. Peas (Dann and Muir 2002), Coffee (Martinati *et al.*, 2008), Strawberry (Kanto *et al.*, 2006) etc by reducing fungicide use and therefore potential environmental threats to land and water has been reduced.

Silicon also alleviates many abiotic stresses including chemical stress (salt, metal toxicity, nutrient imbalance) and physical stress (lodging, drought, radiation, high temperature, freezing, UV) and many others. (Epstein, 1999).Most of these beneficial effects are also attributed to Si deposition in cell walls of roots, leaves, stems and hulls. For example, deposition of Si in the roots reduces apoplastic bypass flow and provides binding sites for metals, resulting in decreased uptake and translocation of toxic metals and salts from the roots to the shoots. Deposition of Si in the culms, leaves and hulls enhances the strength and rigidity of cell walls and decreases transpiration from the cuticle thus, increases the resistance to lodging, low and high temperature, radiation, UV and drought stresses.

It has been shown that Silicon could act as an enhancer of plant defence responses or as an activator of the signalling proteins. Considered to be biologically active, Silicon triggers a faster and more extensive plant defence by interacting with several key components of plant stress signalling systems ultimately leading to induced resistance against pathogenic fungi (Fauteux *et al.*, 2005).

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This study reports the effect of Silicon treatment on the postharvest quality traits and disease suseptibility of tomato fruits.The disease susptibility of fruits to the anthracnose disease has been assessed by artificial inoculation of the fungus to the silicon treated fruits (Si+) and untreted controls (Si-).

METHODOLOGY

Cultivation of Plants

Seeds of the selected cultivar of Tomato "*Thilina*" was obtained from the Department of Agriculture and a field was selected from Doluwa area in the Kandy District, Sri Lanka. Nine vegetable beds were prepared per trial. Two trials were conducted simultaneously. Seeds were dusted using a fungicide and were sown in a nursery bed containing compost, sand and top soil in 1:1:1 ratio. Treated seeds with the fungicide were planted in the nursery bed.

Plant beds (3' X 4') were prepared and 12 planting holes were allocated per plant bed. 30cm gap was left between plants and 50cm gap was left between plant rows. Plant beds were prepared using 2.6g of Urea (chemical formula needed), 13.5g of Phospate fertilizer, 2.6g of Potassium fertilizer per planting hole as basal fertilizer. Application of manure was done 4 days before transplanting the seedlings. Plant beds were well irrigated after the fertilizer application. Two week old seedlings were transplanted in the plant beds. Two tomato seedlings were planted in each hole.

Application of Silicon

Application of silicon was started 2 weeks after transplanting and beds 1 to 7 were used for the experiments. Water soluble silicon, silicon in the form of sodium silicate (23.6% SiO_2, PQ corporation, Toronto) diluted in water was used for the application. Silicon (50mg/L or 100mg/L) was applied weekly to the plants separately based on plant growth stages (Growth period, blooming period and both growth and blooming periods). Allocation of plant beds were as follows. Bed 1 – 50mg/L silicon growth stage, Bed 2 – 50mg/L silicon blooming stage, Bed 3 – 50mg/L silicon growth and blooming stages, Bed 4 – 100mg/L silicon growth stage, Bed 5 – 100mg/L silicon blooming stage, Bed 6 – 100mg/L silicon growth and blooming stages. Bed 7-non treated control. All the above experiments were performed twice.

Determination of physicochemical parameters of fruits

Fruits from plants which received Si treatment fruits and from plants without Si treatment were harvested when they reached harvesting maturity. Fruit extracts were obtained and used to measure Total Soluble Solids (TSS) and percentage titratable acidity (%TA). Total soluble solids (TSS) contents were measured using a hand-held refractometer (WZ-113). Titratable acidity (TA %) was determined according to Askar and Trepow (1993).

Firmness of the fruits was measured using a penetrometer (Wagner Instruments) weight of the fruits was measured using an electronic balance. Size of the fruits was measured using a measuring tape.

Disease development in silicon treated fruits

A spore suspension of *Colletotrichum gleosporioides,* a fungal species causing Anthracnose disease to Tomato fruits was prepared using a pure culture of this fungus. 20 μl of spore suspension (10^5condia per ml) was inoculated to the blossom end and the distal end of treated fruits and control fruits. Then the Fruits were kept in a moisture chamber allowing the fungus to grow. The lesion diameter of inoculated spots was measured 1-7 days after inoculation. Six fruits were used per treatment.

Appressoria formation by Colletotrichum gleosporioides

Thin peel sections were removed from the inoculated spots of plants provided with 6 different treatments and compared with control fruits 48 hrs after the inoculation. These sections were observed under high power of the light microscope and number of appressoria formed in 10 fields of vision was counted.

Statistical analysis

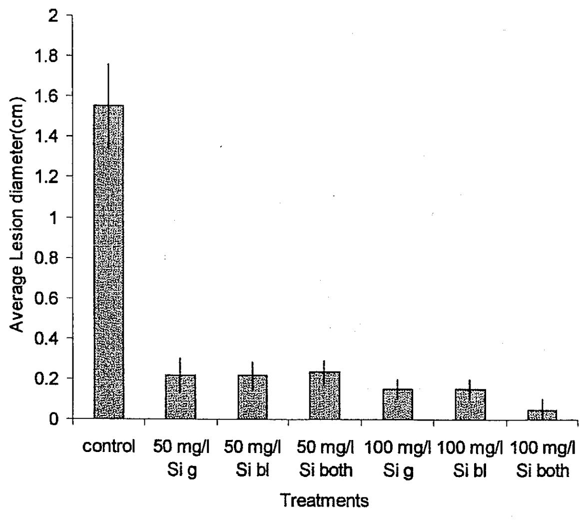
Data were analyzed as a factorial design by ANOVA using SPSS software.

RESULTS AND DISCUSSION

The present study was carried out to investigate the effect of silicon supplementation on postharvest quality traits (physicochemical parameters, TSS, %TA and physical parameters: Size, weight, firmness) and to investigate the disease susceptibility of silicon treated fruits.
The highest total soluble solids was observed (3.24.Brix) in fruits harvested from non treated plants and lowest (2.26.Brix) was observed in fruits harvested from plants treated with 100mg/L Silicon to the growth stage only.

There was no significant relationship between the TSS, %TA or firmness of the fruit treated with silicon compared to non treated control fruits. Similarly, there was no significant relationship observed in size and weight of fruits harvested from plants treated with silicon compared to control fruits.

In addition, the disease susceptibility of silicon treated and non treated control fruits were assessed by artificial inoculation of *C.gleosporioides*. It was found that there is a significant difference in disease development in fruits treated with silicon compared to untreated control fruit (Fig 01). The lesion diameter was lowest (0.05cm) in fruits harvested from the plants treated with 100mg/L at both maturity stages and the highest lesion diameter (1.55cm) was observed in fruits harvested from the non treated control plants. There was no significant difference in lesion diameter of fruit treated with either 50mg/L or 100mg/L or plants supplied with silicon at different growth stages (growth stage only, bloom stage only or both growth and bloom stages).



g-growth stage **bl**- blooming stage both-Si applied both stages (growth and blooming)

Fig 1.Effect of Silicon on anthracnose disease development in tomato fruits five days after inoculation.

Numerous previous evidence indicate that Si could control plant disease caused by fungi and bacteria, such as blast and sheath blight in rice (Datnoff, Deren and Snyder 1997). Powdery mildew in wheat, barley, cucumber and Arabiopsis, ring spot in sugarcane and rust in cowpea.

The enhanced resistance is associated with the higher deposit of silicon in leaf so as to form physical barriers to impede pathogen penetration (Bowen *et al.* 1992) and the activation of host defense response.

It was observed that number of appressoria of *Colletrotrichum gleosporioides* were higher in inoculated spots (Avg. number 40) in fruit peels taken from silicon treated (50mg/L or 100mg/L) fruits than the fruit peels taken from the non treated controls(Avg number 28). Similar finding was recorded by Sara *et al.*, 2001 that surface hardness plays a role in the formation of appressoria in *M. grisea.* It has also been recorded that the specific surface hardness-induced gene expression occurs prior to appressorium formation in *C. gleosporioides.* The present study also revealed that there may be a possibility of the formation of physical barriers in fruit surface by silicon application and thereby a significant reduction of anthracnose development is a possibility.

CONCLUSIONS / RECOMMENDATIONS

Based on this study it can be concluded that silicon either applied in 50mg/l or 100mg/l to the tomato plant at growth, blooming or both maturity stages has a significant effect on reducing anthracnose disease development in tomato fruit.

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