Effect of Nutrition on Postharvest Quality and Grey Mould Development in Strawberries

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Abstract

Strawberries are an extremely perishable fruit mainly due to their soft texture and sensitivity to fungal infection. The fungal pathogen *Botrytis cinerea* is responsible for grey mould on strawberries and is the main causal agent of postharvest decay and subsequent economic loss. As an alternative to fungicides, manipulation of plant nutrition, such as calcium and boron, has been suggested as a means of disease management. This project investigated the effects of calcium and boron application on fruit quality and grey mould development in strawberry.

The effect of calcium on fruit quality, grey mould development and leaf blight in strawberry cultivars 'Aromas' and 'Selva' was investigated through preharvest and postharvest applications. To determine the effect of preharvest application, calcium sulphate in 0.25X strength Hoagland's solution was applied at 0, 100, 300 and 500 ppm Ca through fertigation. Fully-ripened fruit were harvested and evaluated for postharvest quality at harvest and then after storage at 10^{o}C, 90±5% RH for 2 to 10 days. Although fruit firmness of both cultivars declined slightly during storage, this was not affected by preharvest calcium application. Similarly, preharvest calcium treatment had no effect on the external appearance, pH, soluble solids content (SSC) or titratable acidity (TA).

No grey mould development was observed on fruit at harvest when flowers were inoculated with a conidia suspension of *B. cinerea* (10^4 conidia per mL). However, fruit harvested from plants that received calcium at any concentration had less incidence of grey mould during storage at 10^{o}C, 90±5% RH for 14 days than fruit harvested from plants that received no calcium for both cultivars. For 'Aromas', 79% and 51% of fruit, and for 'Selva', 69% and 43% of fruit, showed rot when treated with 0 and 500 ppm Ca, respectively. The shelf life of 'Aromas' and 'Selva' increased by about 8% when plants received 500 ppm Ca in comparison with plants that received 0 ppm Ca.

After 7 days of incubation at 22 to 24^{o}C, there was no difference between blight lesions on wound-inoculated detached leaves from different calcium treatments for either cultivar. However, the lesions on 'Selva' were smaller than on 'Aromas'. The calcium levels in leaves from plants that received calcium at any concentration were adequate for strawberry growing and significantly higher ($P < 0.05$) than in leaves from plants that received 0 ppm Ca. However, calcium treatment did not ensure transfer of calcium to fruit tissues.

Calcium lactate and calcium chloride were used as postharvest calcium treatments at 1500, 3000 and 4500 ppm Ca. Fruit of 'Selva' were dipped in calcium solution for 5 min and wound-inoculated with *B. cinerea* (10^6 conidia per mL). Calcium lactate and calcium chloride at 3000 and 4500 ppm Ca, respectively, were most effective in delaying Botrytis rot development on 'Selva' after 7 days of storage at 10^{o}C, 90±5% RH. Storage for least 24 h after calcium dips prior to inoculation was required to delay the development of fruit rot. Fruit harvested early in the season seemed to be less susceptible to grey mould than those harvested later. However, calcium treatment tended to be more effective when applied to late-season fruit.

Preharvest boron treatment, applied as for calcium but at 0, 0.25, 0.5 and 1.0 ppm B, had no effect on fruit firmness of either cultivar. However, firmness of 'Aromas' fruit was slightly greater than 'Selva' fruit for all treatments. The amount of boron applied had no effect on the external appearance, pH, SSC or TA for either cultivar after storage of fruit for up to 10 days.

Application of boron had no effect on fruit grey mould development in either cultivar. Furthermore, boron had minimal effect on the incidence of blight on wound-inoculated detached leaves of 'Aromas' 7 days after inoculation. However, blight lesion diameters on 'Selva' leaves in the 1.0 ppm B treatment (8.0 mm) were significantly smaller ($P < 0.001$) than in the 0 ppm B treatment (13.0 mm).

Phytotoxicity was observed in boron treatments even at the level considered optimum for strawberry growing. Severity increased with increasing boron concentration but no consistent effect on flower death or flower abortion was observed.

In conclusion, strawberry is sensitive to boron toxicity. Calcium may enhance fruit firmness and, consequently, delay grey mould development if calcium penetrates the fruit. Postharvest calcium treatment tended to be more effective in delaying development of grey mould when applied to late-season fruit. Calcium lactate is a potential alternative to calcium chloride for reducing decay caused by *B. cinerea* in strawberry without providing undesirable bitterness. This finding may provide a basis for application in industry.

Declaration

I declare that the work presented in this thesis contains no material which has been accepted for the award of any other degree or diploma in any university or other tertiary institution. To the best of my knowledge and belief, this thesis contains no material previously published or written by another person, except where due reference has been made in the text.

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Abbreviations

µL	microlitre
ANOVA	Analysis of Variance
ARC	Australian Research Council
B	boron
Ca	calcium
cm	centimetre
DN	day-neutral
e.g.	for example
et al.	and others
FAO	Food and Agricultural Organisation of the United Nations
g	gram
GA	General Appearance
h	hour
i.e.	that is
ICP-OES	Inductively Coupled Plasma Optical Emission Spectrometer (ARL model 3580 B)
kg	kilogram
kgf	kilogram-force
L	litre
LD	long-day
LSD	Least Significant Difference
mg	milligram
min	minute
mL	millilitre
mm	millimetre
mm^2	square millimetre
^oC	degree celsius

pH	potential of hydrogen
ppm	parts per million
RH	relative humidity
RO	reverse osmosis
SARDI	South Australia Research and Development Institute
SD	short-day
SE	standard error
SNW	sterile nanopure water
SSC	soluble solids content
TA	titratable acidity
TSS	total soluble solids
UC	University of California
v/v	volume by volume