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THE EFFECT OF MILD WATER STRESS ON VEGETATIVE GROWTH IN TOMATO (*LYCOPERSICON ESCULENTUM* MILL.) AND *PYRUS BETULAEFOLIA* BUNGE

A thesis presented in partial fulfilment
of the requirements for the degree of
DOCTOR OF PHILOSOPHY
in
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at Massey University

Andrew Barrington Saunders
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THIS THESIS IS DEDICATED TO
MY DEAREST WIFE
CHRISTINE

... blessed is the man that trusts in the Lord,
whose confidence is in him.
He will be like a tree planted by the water
that sends out its roots by the stream.
It does not fear when heat comes;
its leaves are always green.
It has no worries in a year of drought
and never fails to bear fruit.

Jeremiah 17:7-8.

ABSTRACT

The effects of mild water stress and physical root restriction on leaf parameters and assimilate partitioning have been studied in order to understand and refine orchard management techniques which utilise both of the above stress elements (e.g. regulated deficit irrigation (RDI)).

Initially, a system for applying a controlled level of water stress was developed and plant responses within this system defined. The system involved using aeroponic tanks with water stress generated by cycling the misting pumps on and off (intermittent misting). Similar systems have been used by other workers to stimulate hormonal changes but no work has been reported detailing vegetative growth responses. The intermittent misting technique was compared to polyethylene glycol (PEG) generated water stress, using tomato (*Lycopersicon esculentum* Mill. cv. Virosa F1) as a model plant.

Water stress studies were then carried out on *Pyrus betulaefolia* (an important root-stock for the asian pear (nashi) fruit crop (*Pyrus serotina*)) using intermittent misting. These results were compared to those from a root restriction trial involving *P. betulaefolia* in a circulating hydroponic system.

The performance of polyethylene glycol in the aeroponic system appeared to be better than in the various hydroponic systems which have been reported. Polyethylene glycol 4000 gave the best results (from PEG 1000, 4000 and 6000), in terms of in minimum level of phytotoxicity, up to a total nutrient solution water potential (Ψ_W) of around -6 bar.

Under an intermittent misting regime, tomato plants were subjected to a range of misting pump off-times up to 1.55 hours, with a constant on-time of 1 minute (to saturate the root system). It was found that important plant parameters could be related in a negative logarithmic fashion to misting pump off-time (e.g. leaf Ψ_W, plant part dry weights, allometric k value, net photosynthetic rate and stomatal conductance). For *P. betulaefolia* trees, exposed to misting pump off-times of up to two hours, plant parameters were also related to the negative logarithm of the misting pump off-time. This was despite the fact that the tomato seedlings grew approximately exponentially while *P. betulaefolia* plants grew in a more linear fashion. Hence it was concluded that intermittent misting was an ideal method for generating a controlled water stress (under which plant responses could be predicted) in both pure and applied experimental work.

Under physical root restriction (with water stress minimized), no significant differences were found in several important parameters, including net photosynthetic rate. Also, in contrast to the water stress response, assimilate partitioning to the shoot system increased (increase in the allometric k value). The relative increase in partitioning was greatest in the stem component, this being the plant part most severely affected by water stress.

Under both water stress and physical root restriction the allometric k value appeared to change rapidly, following application of the treatment, and then remain constant. This constancy was tested by using a previously unutilized plot involving the shoot/root ratio *versus* time linearized plant dry weight.

The results of plant responses to both water stress and physical root restriction are discussed in relation to vegetative growth control measures in fruit crops such as RDI. Consideration is also given to the overall mechanisms behind observed growth responses under the two stress regimes.

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