STUDIES OF THE FACTORS AFFECTING THE YIELD AND QUALITY OF SINGLE TRUSS TOMATOES

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1996

A thesis presented in partial
fulfilment of the requirements
for the degree
of Doctorate of Philosophy in
Horticultural Science at
Massey University

ABSTRACT

This research was conducted to evaluate the potential of the single truss system of tomato production to produce high yields of quality fruit under New Zealand conditions. The NFT hydroponic system was used to grow the plants so that nutrient solution conductivity could be maintained close to predetermined levels.

In the first experiment three cultivars were compared. At the time of fruit set of the first truss four conductivity treatments (2, 4, 6 and 8 mS cm^{-1}) were applied. Yield and fruit quality data was obtained from each of six crops over an 18 month period. Yield (fruit size) decreased with increasing conductivity for all three cultivars. Season also had a significant effect on yield, with an April harvested crop having the highest yield. Both fruit brix and titratable acidity were increased at the higher conductivity levels. There were also cultivar and seasonal differences in fruit quality, with the cherry cultivar 'Cherita' consistently producing the highest brix and titratable acidity levels. Brix levels were found to be low in the December harvested crop, while acidity was highest in the December, April and July harvested crops. Season, solution conductivity and cultivar influenced plant leaf area and leaf area index. Solution conductivity also effected foliar mineral levels, as did cultivar.

Three successive multi truss crops were grown in a pumice media system to provide fruit quality data for sensory evaluation and comparison with single truss and commercial compositional fruit quality. The same three cultivars as were compared in the single truss crop experiment were grown at three conductivity levels (2, 4 and 6 mS cm^{-1}) applied at the time of fruit set of the first truss. Fruit samples were taken from the 5th and 6th trusses for quality evaluation. Season and solution conductivity had an effect on fruit dry matter percentage and brix. Fruit shelf life was affected by season, conductivity and cultivar, with a longer shelf life obtained from fruit grown at the higher conductivity levels. The December harvested crop had the lowest overall shelf life. Fruit firmness was only affected by solution conductivity, with the fruit from the higher

conductivity treatments being firmest. Sensory evaluation of Rondello fruit on three separate occasions showed that the higher conductivity treatment scored highest for most attributes, and that these sensory scores correlated well with brix and titratable acidity levels.

A second single truss crop experiment focused on manipulation of the source/sink relationship (fruit and leaf number combinations) of three successional crops and the effect of spring and winter CO_2 enrichment on two of the three crops. The summer crop also evaluated the effect of crop shading and source/sink relationship on fruit yield, as high fruit temperatures were suspected to have reduced yield in the previous summer single truss crops. Yield and fruit quality data was collected from all three crops, along with fruit and environmental temperature recordings from the summer crop. It was found that season and fruit number effected yield, with the 8 fruit per plant treatment resulting in the greatest yield. Leaf number (either 2 or 3) and season affected fruit dry matter percentage, brix and leaf area, while fruit number influenced brix levels. CO_2 enrichment (1000 ppm) had no effect on either spring or winter fruit yield, but did advance crop maturity allowing an extra crop per year to be produced. Thus yearly yield was increased by CO_2 enrichment. CO_2 enrichment improved fruit quality in the spring crop, but had no effect on the winter crop. Shading of the summer crop resulted in an increase of 10% in total fruit yield and 19% in marketable fruit yield, due to the presence of smaller fruit and heat induced ripening disorders in the unshaded crop. Both leaf number and shading treatments affected titratable acidity, with unshaded fruit having greater percent citric acid levels. Shelf life and fruit firmness was greater in the shaded crop. Air, canopy and fruit temperatures were reduced under shade, with exposed fruit often reaching extreme temperatures (above 40°C).

Having established that leaf and fruit temperatures were reaching extreme levels during the summer in a single truss cropping situation, the effect of these temperatures on photosynthesis and fruit respiration was examined. The effect of leaf age on photosynthesis was also examined as single truss plants do not continue to produce young foliage to maintain photosynthesis levels. After harvest, net photosynthesis and the light compensation point, which had been increasing began to fall rapidly at all light

levels. It was found that after an initial drop as leaves matured, leaf age did not effect net photosynthesis. Plants exposed to 800 PAR showed maximum net photosynthesis at temperatures between 25 - 27°C. Net photosynthesis ceased at 43°C.

Fruit truss respiration rates were determined at 4 temperatures (25, 30, 35 and 40°C), on 3 occasions (18, 26, 36 and 40 days after fruit set). 5 different tissue sample combinations were assessed comprising, the whole truss with sealed and unsealed cut surfaces, fruit only with sealed and unsealed calyx scar and calyx, peduncles and plant stem only. It was found that temperature, truss portion assessed and stage of fruit maturity all affect fruit respiration rate, with the fruit only (calyx scar unsealed) resulting in the greatest CO_2 efflux. It was concluded that while the fruit epidermis is relatively impermeable to gas escape, the main route for CO_2 is through the calyx scar. Mature green fruit had the greatest response of increased CO_2 production with increasing temperature, while temperatures above 25°C disrupted the climacteric pattern of CO_2 evolution. It was concluded that in single truss plants, when temperatures were above 30°C, net photosynthesis is reduced, while fruit respiration begins to increase rapidly, both responses having a detrimental effect on yield.

The single truss system was shown to produce yields and fruit quality equal to those of good multi truss commercial tomato producers in New Zealand. This was achieved by CO_2 enrichment for crop advancement and summer crop shading, while moderate levels of solution conductivity produced good quality fruit. However, there is the possibility of further improving these yields by utilisation of other technologies such as a movable bench system and manipulation of plant density, timing of conductivity application, and different cultivars. The potential of this system for high quality, high yielding tomato fruit production warrants commercial evaluation.

ACKNOWLEDGEMENTS

I would like to thank the following people for their support, input and encouragement during the research and preparation of this thesis:

my supervisors Dr Keith Fisher and Dr Mike Nichols for their guidance and patience, their sharing of knowledge and never ending supply of ideas.

Professor Errol Hewitt, Dr Nigel Banks, Chris Rawlingson and Suzie Newman for their advice, interest and assistance with the postharvest component of this research.

Dr David Woolley for his input into the design of the photosynthesis and respiration experimentation and subsequent discussion.

the staff of the Plant Growth Unit, particularly Bryan Sturgess, Ray Johnstone and Charlie Forbes who provided valuable assistance with the NFT systems, growth cabinets, respiration chambers, greenhouse environment and who always managed to fix those things that broke down.

my panel of trained tomato tasters and all those staff and students who participated in numerous panel selections, whose enthusiasm and interest was greatly valued.

the Packhouse association of NZ (PANZ) who provided industry information and commercial fruit samples for quality assessment.

the Vice Chancellors study grant fund, C Alma Baker trust and the Helen Alkers trust whose financial support was greatly appreciated.

the staff and students of the Plant Science department for their interest, support and friendship during the last 4 years.

my parents, Pam and Keith Morgan for their encouragement, financial support, and insistence that I get a higher education.

my husband Simon for his technical assistance, emotional support, hours of proof reading and for not ever letting me give up.

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