Growth and yield measurements to detect treatment differences in tomato crops in modern greenhouses

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Abstract

Growth and yield measurements were made in tomato crops grown for many months in two modern greenhouses in the Auckland region. The measurements were based on the methodology used to predict crop yield in northern hemisphere crops. Ten plants per treatment was a sufficiently large sample to demonstrate significant differences. Obtaining data was not costly. The measurements describe the amount of crop growth and yield as well as the growers' crop management practices.

Additional keywords: Auckland region, Flavourine, Conqueror.

Introduction

Crop measurements in modern greenhouses are done primarily for decision support and are not completely suitable for detecting treatment differences in agronomic studies. Because of rapid advances in technology there is an increasing need to conduct agronomic trials on greenhouse crops in the most modern facilities. The chance of conducting such trials at research stations or tertiary institutions in New Zealand is rapidly receding. We have had the opportunity to record growth and yield of tomato crops in two neighbouring, similar greenhouses since June 2004. The results are described and discussed in this paper.

Materials and Methods

Recordings were made, starting in June 2004, on plants within commercial tomato crops in two double plastic covered greenhouses in Waimauku. The greenhouses were similar in size (4000m^2), construction, growing systems, temperature and humidity settings, radiation received, irrigation treatments, electrical conductivity (EC), nutrition, crop management systems. Photosynthetically active radiation within the greenhouses was about one third of total incoming solar radiation.

Four week old plants of cv Conqueror (plum tomato) in House B and cv Flavourine (truss tomato) in both House A and B were planted in mid-June 2004. Measurments on Conqueror in House B and Flavourine in House A began on 30 June and on Flavourine in House B on 8 September. Vegetative measurements taken or derived at 14 day intervals from 10 plants in each cultivar included plant height, leaf length just above truss 4 (or lowest truss in very young plants), number of leaves and active plant height (= the distance from the lowest truss carrying fruit at the previous measurement to the top of the plant). The number of trusses of fruit harvested since the previous measuring date was recorded from when harvesting began in mid-October. Our information was similar to that recorded or derived by Canadian advisors (Portree *et al*., 1996) and the Substratus Horticultural Crop Consultancy of Holland, one of the world's largest greenhouse vegetable crop consultancy companies.

Analysis of variance and covariance were undertaken with the GENSTAT statistical package GenStat® Release 6.1 (Payne 2002). Smooth curves were fitted to scatterplots using the loess function, (Cleveland *et al*, 1992).

Table 1. Growth and yield measurements in the first half and near the end of crop life.

	Treatment	**22.9.04***	**4.5.05**
Plant height	Flavourine A	2.12	8.17
(m)	Flavourine B	2.22	9.47
	Conqueror A	2.59	9.83
$LSD_{0.05}$ (df =15)	Fla A v Fla B	0.08	0.41
	Fla B v Con B	0.09	0.63
p-values	Fla A v Fla B	0.015	<0.001
	Fla B v Con B	<0.001	0.41
Leaf length	Flavourine A	442	401
(mm)	Flavourine B	409	470
	Conqueror A	404	436
$LSD_{0.05}$ (df =15)	Fla A v Fla B	19	30
	Fla B v Con B	41	31
p-values	Fla A v Fla B	0.002	<0.001
	Fla B v Con B	0.012	0.031
Number of	Flavourine A	3.4	28.0
Trusses harvested	Flavourine B	3.8	29.0
	Conqueror A	3.7	29.0
$LSD_{0.05}$ (df =15)	Fla A v Fla B	0.8	1.5
	Fla B v Con B	0.7	1.6
p-values	Fla A v Fla B	0.32	0.22
	Fla B v Con B	0.42	0.69
Leaf number	Flavourine A	17	13
	Flavourine B	17	17
	Conqueror A	22	21
$LSD_{0.05}$ (df =15)	Fla A v Fla B	1.0	1.9
	Fla B v Con B	1.6	1.9
p-values	Fla A v Fla B	0.69	<0.001
	Fla B v Con B	<0.001	<0.001
Active plant	Flavourine A	1.52	1.09
height (m)	Flavourine B	1.61	1.98
	Conqueror A	2.14	2.25
$LSD_{0.05}$ (df =15)	Fla A v Fla B	0.08	0.12
	Fla B v Con B	0.09	0.18
p-values	Fla A v Fla B	0.040	<0.001
	Fla B v Con B	<0.001	0.006

* first recording date for number of trusses harvested is 20.10.04.

Figure 1: Accumulating plant height (m) of June planted Flavourine in House A and Conqueror and Flavourine in House B in 2004-05.

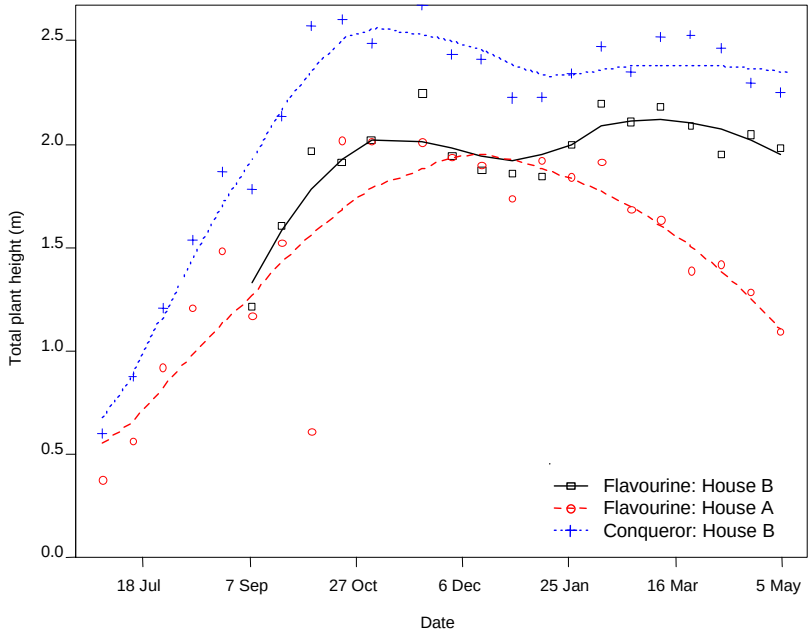


Figure 2: Active stem length (m) of June planted Flavourine in House A and Conqueror and Flavourine in House B in 2004-05..

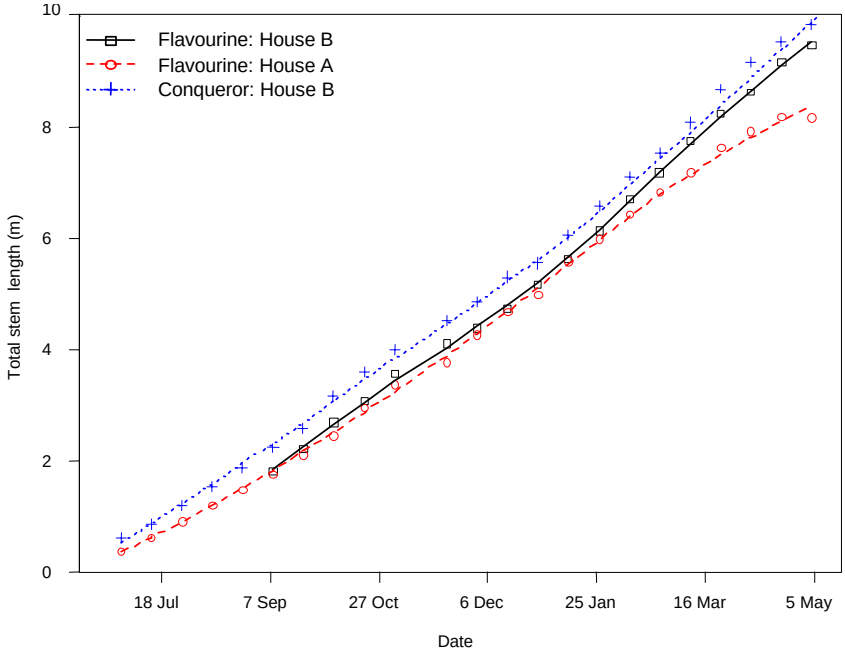


Figure 3: Length (mm) of leaf above the 4th truss from the top of the plant on June planted Flavourine in House A and Conqueror and Flavourine in House B in 2004-05.

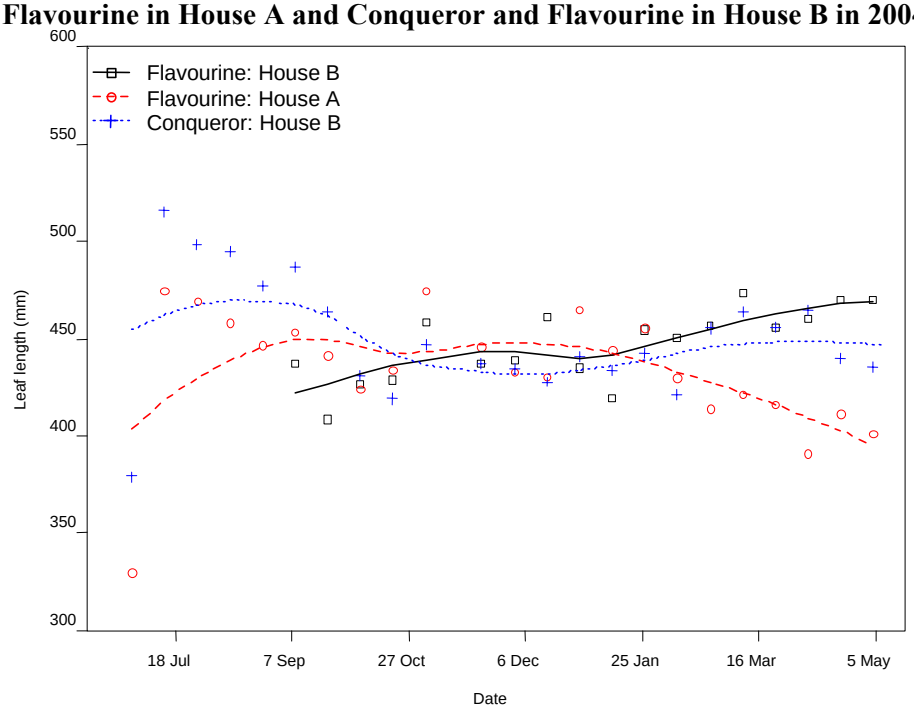


Figure 4: Number of leaves on June planted Flavourine in House A and Conqueror and Flavourine in House B in 2004-05.

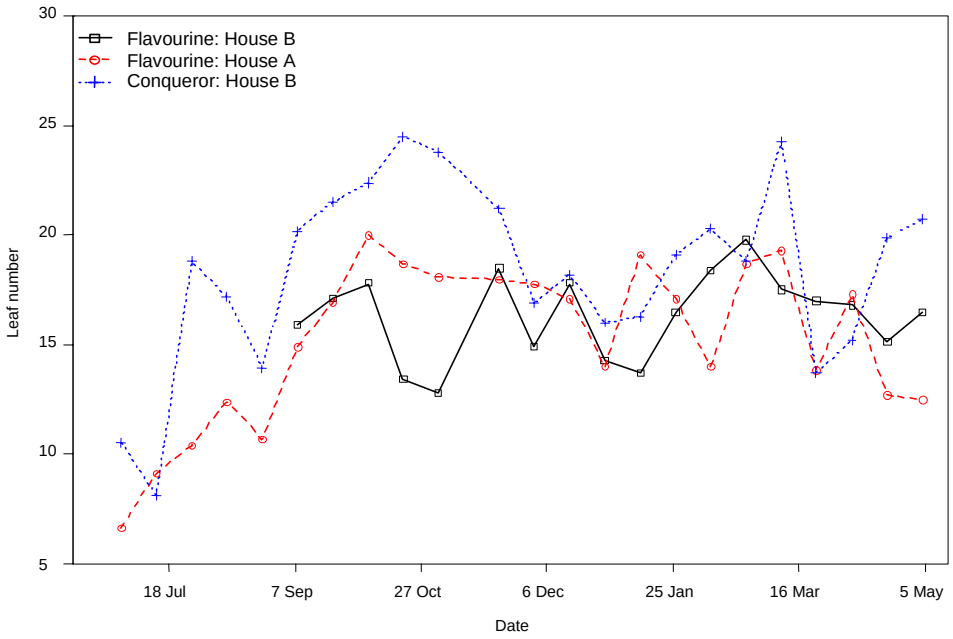
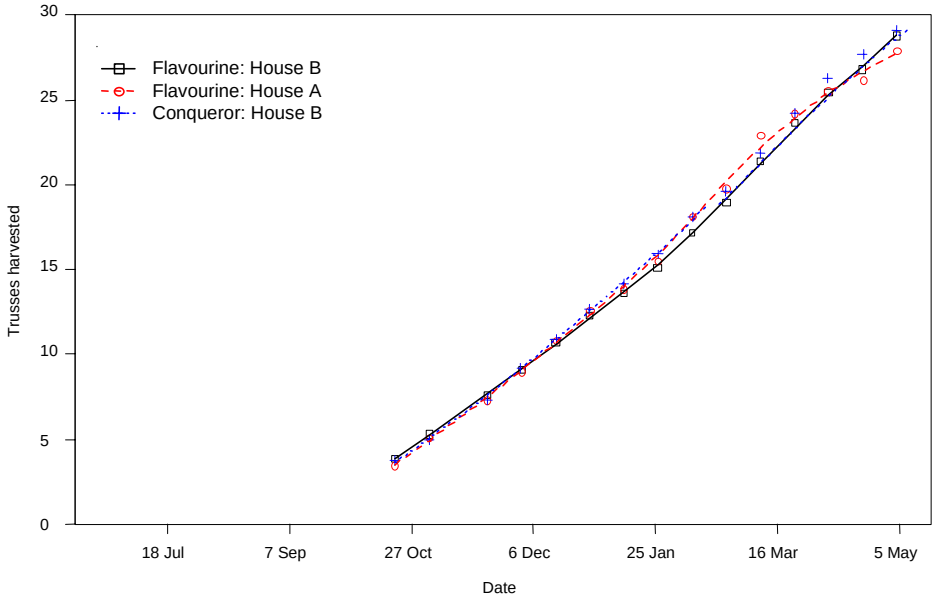


Figure 5: Accumulating number of trusses harvested between each recording date for June planted Flavourine in House A and Conqueror and Flavourine in House B.



Results and Discussion

Significant differences between treatments were obtained for most growth measurements but not the yield measurements on the two dates data were analysed (Table 1). Thus, measuring 10 plants of each cultivar in each house has been an adequate number of plants to detect treatment differences. Collecting data took two people approximately 30 minutes for each group of 10 plants.

The measurements of plant height (Figure 1), active plant height (Figure 2) and leaf length (Figure 3) reflected both environment and crop management practices. The leaf number measurements (Figure 4) reflected only crop management practices. Despite leaf removal practice being different in the two houses, yield (Figure 5) was the same in Flavourine to the beginning of May.

Plant height increased at a similar rate for both cultivars in both houses and during most times of the year, with a slight increase in growth rate in Flavourine in House B in January (Figure 1). In early February the rate of increase in plant height was greater in House B than in House A for Flavourine. The significant difference in plant height found at the two dates analysed (Table 1) probably occurred throughout the cropping season.

The length of the active stem was significantly different between cultivars and between greenhouses for the same cultivar at the two dates analysed (Table 1). This measurement indicated how much of the stem was contributing to fruit production. Variability in internode length will affect both total and active plant height.

Early in the season Conqueror plants had longer leaves than Flavourine plants (Figure 3). From October until early February, Conqueror and Flavourine in both House A and B had similar leaf lengths. Later in the season both cultivars in House B had greater leaf lengths than Flavourine in House A. Northern hemisphere publications suggest that in low latitudes, areas of high radiation (2000J/cm^2/day) and high light intensity (>800W) leaf lengths of a well balanced plant should be between 400 and 450 mm. Summer radiation in the Auckland region is likely to exceed 2000J/cm^2/day (NIWA, 2005). Leaf

lengths in the first two months were mostly over 450 mm but later were between 400 and 450 mm (Figure 3).

The differences in number of leaves per plant during the season were due to management decisions about leaf removal (Figure 4). Leaves were removed more frequently in House A than in House B from mid-summer (Figure 4). This decision probably led to less vegetative growth in autumn and the further decision to remove growing points from plants, commonly done 4 - 6 weeks before crop removal, in late April in House A.

The number of trusses harvested in both Flavourine crops between recording periods was not significantly different throughout the growing season (Table 1) in spite of reduced vegetative growth in House A from February. The reduced vegetative growth was expressed as reduced crop longevity before being expressed as reduced yield. Lower frequency of leaf removal in autumn was likely to be an important factor in extending the life of winter or spring planted greenhouse tomato crops in the Auckland region.

Acknowledgements

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