VG025
The development of technology to adapt and maximise the drip irrigation system

Jeff Barnes
Queensland Department of Primary Industries

Know-how for Horticulture™

VG015

This report is published by the Horticultural Research and Development Corporation to pass on information concerning horticultural research and development undertaken for the vegetable industry.

The research contained in this report was funded by the Horticultural Research and Development Corporation with the financial support of the Queensland Fruit & Vegetable Growers.

Cover Price $20.00

HRDC ISBN 1 86423 450 4

Published and Distributed by:

Horticultural Research and Development Corporation
Level 6
7 Merriwa Street
Gordon NSW 2072

Telephone: (02) 9418 2200
Fax: (02) 9418 1352

HORTICULTURAL RESEARCH AND DEVELOPMENT CORPORATION

AND

QUEENSLAND FRUIT AND VEGETABLE GROWERS ASSOCIATION

1.	**Project Title:**	The development of technology to adapt and maximise the drip irrigation system
	Reference No.:	VG 015
2.	**Organisation:**	Queensland Department of Primary Industries
	Postal Address:	GPO Box 46, Brisbane Q 4001
3.	**Project Chief Investigator:**	J.A. Barnes
4.	**Commencement Date:**	1 July 1990
	Completion Date:	30 June 1993

---

5. Summary.

The effect of different irrigation regimes in both the early and late stages of crop development were studied in an attempt to refine the water application recommendations for trickle irrigation of fresh market tomatoes. The effect of late stage water restriction on fruit flavour was of particular importance. The amount of water applied was determined by the evaporation since the previous irrigation and adjusted by a crop factor which was dependent on the age of the crop. Heavy rain at some stage during most of the experiments made interpretation of results difficult and highlighted the difficulties of conducting irrigation experiments where there is no control over natural precipitation. Restriction of irrigation below 100% ET in the early stages from flowering until 2 weeks prior to harvest caused losses in total yield, marketable yield and yield of first grade fruit. The early 100% ET treatment resulted in the highest percentage first grade fruit and highest percentage marketable fruit. Late irrigation treatments (from 2 weeks prior to harvest and through the harvest period) had little effect. There was no advantage in increasing the late irrigation application above 50% ET. The late 25% treatment reduced average fruit weight causing greater percentages of the smaller sized fruit and corresponding lower percentages of the larger sized fruit. Total soluble solids increased very slightly with reduced water application implying that improvements in total soluble solids levels and flavour of tomato fruit must remain a priority in the breeding program.

TECHNICAL REPORT

The development of technology to adapt and maximise the drip irrigation system

Introduction

Trickle irrigation has found rapid acceptance in fresh market tomato production. Tomatoes have shown a marked sensitivity to water stress, with irrigation increasing yields substantially. Trickle irrigation increased tomato yield when compared to sprinkler and/or furrow irrigation. It has also been effective in reducing total water requirements for tomatoes.

Although increased amount of water increase tomato yield, the important quality factors of total soluble solids and acidity, particularly for processing tomatoes, were found to be inversely related to yield increases from irrigation. While there are a number of components affecting tomato flavour, total soluble solids and acidity are two important aspects to consider. Fruit with high total soluble solids are reported to have better flavour.

There has been considerable adverse publicity regarding tomato fruit quality, including flavour, in recent years. Breeding tomatoes with improved flavour is one approach which is being pursued. However, trickle irrigation offers the opportunity for careful management of water application with the potential for maximising the production of good quality fruit. There is also the possibility of improving tomato flavour with manipulation of water application, particularly late in the crop. Some earlier research in Australia with processing tomatoes suggested that reducing irrigation rates to 75% of evapotranspiration from fruit-fill may achieve higher soluble solids with minimal yield loss while further reductions to 50% of evapotranspiration may result in significant losses in productivity.

Our studies were designed to investigate the effects of different irrigation regimes under the trickle irrigation, plastic mulch production system on fresh market tomato yield and fruit quality. Of particular interest was the effect of water restrictions late in the crop on the levels of total soluble solids.

Materials and methods

Site

Experiments were conducted at Bundaberg Research Station, Queensland during 1990 to 1992 on a prepared euchrozen soil.

Experimental designs

Four experiments were conducted as follows:

Experiment 1 Spring-Summer season 1990
Experiment 2 Spring-Summer season 1991
Experiment 3 Autumn-Winter season 1992
Experiment 4 Spring-Summer season 1992

In each experiment there were 12 treatments consisting of early and late irrigation treatments.

Treatment schedule

Early treatments. From flowering until 2 weeks prior to first harvest, 3 treatments were applied over the 12 plots as follows:

Experiment 1: T1 = 0.50 Epan x Crop factor (0.50 ET)
T2 = 0.75 Epan x Crop factor (0.75 ET)
T3 = 1.00 Epan x Crop factor (1.00 ET)

Experiments 2, 3, and 4:
T1 = 0.25 Epan x Crop factor (0.25 ET)
T2 = 0.50 Epan x Crop factor (0.50 ET)
T3 = 1.00 Epan x Crop factor (1.00 ET)

Late treatments. From 2 weeks prior to first harvest until final harvest, 4 further treatments were applied to each of the 3 early treatments as follows:

T4 = 0.25 Epan (0.25 ET)
T5 = 0.50 Epan (0.50 ET)
T6 = 0.75 Epan (0.75 ET)
T7 = 1.00 Epan (1.00 ET)

Treatment No.	Treatment		Treatment No.	Treatment	
1	T1	T4	7	T2	T6
2	T1	T5	8	T2	T7
3	T1	T6	9	T3	T4
4	T1	T7	10	T3	T5
5	T2	T4	11	T3	T6
6	T2	T5	12	T3	T7

Treatments T1, T2 and T3 were modified by a crop factor to allow for plant size. The crop factor at flowering (4 weeks old) was 0.5. The crop factor was increased by 0.1 each week as the crop developed until a maximum of 1.0 was reached (9 weeks old).

The 12 treatments were randomised within a complete block and each block was replicated 4 times. Plots consisted of 3 rows, each 10 m long. The middle row was the datum row with the row either side being a buffer row. Each datum row had a 3 m buffer area at each end to avoid competition effects due to the different irrigation treatment of the next plot. Plants were spaced 0.5 m apart. The harvested (datum) area of each plot was 4 m (8 plants). All plots had individual feeder lines closed by taps so that each plot could be isolated from each of the other plots for ease of application of the differing irrigation treatments.

Cultural practices

Tomato seedlings of advanced breeding line FDA3 were raised in Speedling trays. Seedlings (5 to 6 weeks after emergence) were transplanted into raised beds covered with black polyethylene mulch. A single drip irrigation tube for each row was laid under the mulch. The tube with emitters

spaced 300 mm apart was located under the mulch 75 mm to the side of each plant row.

During the bed-shaping operation, a complete NPK (4.2 : 5.7 : 6.7) fertiliser (1280 kg/ha) was incorporated in the bed with a rotavator attachment on the bed shaper. At the same time, a granular formulation of fenamiphos (Nemacur 100g, 100 g a.i/kg) for root-knot nematode (*Meloidogyne* spp.) control was incorporated over a 600 mm-wide strip of the bed at 13.3 g/m^2. Petiole samples of the most recent fully expanded leaf were taken weekly and the sap analysed for nitrate-N and potassium concentrations using Merkoquant test strips. Soluble nitrogen and potassium fertiliser was injected into the irrigation water as required according to the sap tests. Normal management for disease and pest control was carried out.

The crop received normal irrigation following field planting and during the establishment phase. Treatments commenced at flowering (4 weeks after field planting). Treatments were applied on Monday, Wednesday and Friday of each week and were based on evaporation since the previous irrigation. A Class A pan provided the evaporation data. In a number of instances rain interfered with proposed treatments. Where possible, adjustments of applied irrigation were made to counteract rainfall. However, this was not always possible and some treatment effects were lost.

Measurements

The crops were harvested twice weekly. Plot yield and fruit number were measured. All fruit were assessed for size and blemish. Around mid-harvest a sample of 15 fruit per plot was selected for quality assessment. Fruit were harvested at breaker stage (USDA 2) and held at 20^0 for 6 days (USDA 6). The sample was then snap frozen and held for chemical determination of quality parameters (total soluble solids, pH, titratable acidity and conductivity) at a later date.

Statistical analysis

Data were subjected to an analysis of variance. The protected l.s.d. procedure was used for the comparison of means at P = 0.05.

Results

Water application

Tables 1 to 4 show for each of the main treatments the amount of irrigation water applied, rainfall received, total amount of water received as well as the planned water application for each of the 4 experiments. Experiment 1 (Table 1) was the only experiment that did not receive any rain during the life of the experiment and treatments could be applied as planned and without adjustments for rain. In experiment 2 (Table 2) heavy rainfall during the late stage treatments and in experiment 3 (Table 3) heavy rainfall during the early stage treatments negated any planned treatment effects. Allowances for rainfall during the other stage in these 2 experiments could be made by adjusting the rate of irrigation such that, in most cases, the amount of water received approached the planned water application. This could also be done for the early stage treatments in experiment 4 (Table 4). However, rainfall during the late treatment stage of this experiment could not be adjusted for fully and treatments received more water than was planned.

Table 1. Experiment 1: Evaporation - early treatment stage 221.6 mm
- late treatment stage 290.7 mm

Treatment stage	Treatment	Water applied (mm)	Rainfall (mm)	Water received (mm)	Planned water application (mm)
Early	0.50 ET	74.4	0	74.4	74.4
treatments	0.75 ET	111.6	0	111.6	111.6
	1.00 ET	148.8	0	148.8	148.8
	0.25 ET	71.4	0	71.4	71.4
Late	0.50 ET	142.9	0	142.9	142.9
treatments	0.75 ET	214.3	0	214.3	214.3
	1.00 ET	285.8	0	285.8	285.8

Table 2. Experiment 2: Evaporation - early treatment stage 218.4 mm
- late treatment stage 268.0 mm

Treatment stage	Treatment	Water applied (mm)	Rainfall (mm)	Water received (mm)	Planned water application (mm)
Early	0.25 ET	32.3	45.8	78.1	38.0
treatments	0.50 ET	64.5	45.8	110.3	76.0
	1.00 ET	135.6	45.8	181.4	152.0
	0.25 ET	22.6	251.8	274.4	66.5
Late	0.50 ET	45.3	251.8	297.1	132.9
treatments	0.75 ET	72.0	251.8	323.8	199.4
	1.00 ET	98.7	251.8	350.5	265.9

Table 3. Experiment 3: Evaporation - early treatment stage 205.7 mm
- late treatment stage 125.5 mm

Treatment stage	Treatment	Water applied (mm)	Rainfall (mm)	Water received (mm)	Planned water application (mm)
Early	0.25 ET	10.5	218.4	228.9	43.2
treatments	0.50 ET	23.3	218.4	241.7	86.5
	1.00 ET	91.0	218.4	309.4	173.0
	0.25 ET	10.4	48.6	59.0	31.4
Late	0.50 ET	30.5	48.6	79.1	62.8
treatments	0.75 ET	58.1	48.6	106.7	94.1
	1.00 ET	77.4	48.6	126.0	125.5

Table 4. Experiment 4: Evaporation - early treatment stage 223.3 mm
- late treatment stage 260.1 mm

Treatment stage	Treatment	Water applied (mm)	Rainfall (mm)	Water received (mm)	Planned water application (mm)
Early	0.25 ET	36.9	21.4	58.3	41.0
treatments	0.50 ET	73.9	21.4	95.3	82.0
	1.00 ET	147.7	21.4	169.1	164.0
	0.25 ET	28.8	154.2	183.0	65.0
Late	0.50 ET	57.7	154.2	211.9	130.0
treatments	0.75 ET	99.7	154.2	253.9	195.0
	1.00 ET	146.6	154.2	300.8	260.0

Total yield, marketable yield, yield of first grade fruit

The late stage treatments did not cause significant ($P>0.05$) differences for either total yield, marketable yield or yield of first grade fruit in any of the 4 experiments (Table 5). In experiment 2, treatment T3 was significantly ($P<0.05$) greater than T1 for total yield, marketable yield and yield of first grade fruit. Treatment T3 was significantly ($P<0.05$) greater than both T1 and T2 for the same parameters, in experiment 4 (Table 5). Again for the same parameters for experiment 4, treatment T2 was significantly ($P<0.05$) greater than T1.

Percentage first grade fruit, percentage marketable yield

Experiment 4 was the only instance where early irrigation treatments affected percentage first grade fruit. Treatment T3 was significantly ($P<0.05$) greater than either T1 or T2 (Table 6). The effect of late treatments on this parameter gave a confusing result. With percentage marketable yield, treatment T3 was significantly ($P<0.05$) greater than T1 or T2 in experiment 4. T2 was significantly ($P<0.05$) greater than T1 (Table 6). The same trend of early treatments for experiments 2 and 3 was not as clear cut. Late irrigation treatments did not greatly affect percentage marketable yield in any of the 4 experiments (Table 6).

Table 5. Total yield, marketable yield and yield of first grade fruit of main treatment effects of experiments 1, 2, 3 and 4.

Means within columns followed by a common letter are not significantly different at P = 0.05.
NS = F test not significant.

Treatments	Expt. 1	Expt. 2	Expt. 3	Expt. 4
		Total yield (kg)		
T 1	47.40	54.44 b	43.60	54.05 c
T 2	48.00	57.66 ab	45.23	62.05 b
T 3	49.07	60.70 a	43.11	65.90 a
l.s.d. (P = 0.05)	NS	3.61	NS	3.14
T 4	46.54	58.25	44.03	59.26
T 5	46.92	57.52	43.43	60.75
T 6	49.59	57.56	44.41	60.45
T 7	49.57	57.06	44.04	62.20
l.s.d. (P = 0.05)	NS	NS	NS	NS
		Marketable yield (kg)		
T 1	42.48	42.01 b	38.60	40.44 c
T 2	42.95	46.61 a	39.55	48.95 b
T 3	44.18	49.58 a	38.60	55.43 a
l.s.d. (P = 0.05)	NS	3.63	NS	4.14
T 4	42.44	47.02	38.48	46.51
T 5	42.64	45.75	38.52	47.85
T 6	43.44	46.42	39.00	49.45
T 7	44.29	45.07	39.67	49.28
l.s.d. (P = 0.05)	NS	NS	NS	NS
		Yield of first grade fruit (kg)		
T 1	33.56	36.00 b	33.14	31.98 c
T 2	34.32	39.85 a	33.50	38.71 b
T 3	35.52	42.79 a	33.08	44.22 a
l.s.d. (P = 0.05)	NS	3.58	NS	4.04
T 4	35.45	40.64	32.94	37.38
T 5	34.66	39.80	32.82	37.18
T 6	33.52	39.49	32.74	39.63
T 7	34.22	38.24	34.45	39.03
l.s.d. (P = 0.05)	NS	NS	NS	NS

Number of fruit, average fruit weight

In experiment 4, number of fruit in treatment T3 was significantly (P<0.05) greater than T1 or T2. T2 was significantly (P<0.05) greater than T1 (Table 7). This was the only case over the 4 experiments where there were any significant differences in fruit number as a result of the differing treatments. Average fruit weight did not show big differences due to irrigation treatments (Table 7).

Percentage small, percentage medium, percentage large, percentage extra-large fruit

There were some differences in percentage of the various fruit sizes, particularly in the medium and large sizes, as a result of irrigation treatments (Table 8). In experiment 4 for the early irrigation treatments, T1 had a significantly (P<0.05) greater percentage of medium size fruit than T2 or T3. T2 and T3 were not significantly (P>0.05) different. Considering the late irrigation treatments in experiments 1, 2 and 4, T4 had significantly (P<0.05) greater percentages of medium size fruit than either T5, T6 or T7 which were not significantly (P>0.05) different from each other. For the percentage of large fruit for these 3 experiments, the opposite effect occurred where T4 had significantly (P<0.05) smaller percentages than either T5, T6 or T7 which were again not significantly (P>0.05) different from each other. In experiment 4 for the early irrigation treatments, T3 had a significantly (P<0.05) greater percentage of large fruit than T1 (Table 8).

Table 6. Percentage first grade fruit and percentage marketable yield of main treatment effects of experiments 1, 2, 3 and 4.

Means within columns followed by a common letter are not significantly different at P = 0.05.
NS = F test not significant.

Treatments	Expt. 1	Expt. 2	Expt. 3	Expt. 4
		Percentage first grade fruit		
T 1	70.83	66.10	76.04	58.59 b
T 2	71.58	69.17	74.17	62.24 b
T 3	72.29	70.43	76.85	67.24 a
l.s.d. (P = 0.05)	NS	NS	NS	4.97
T 4	76.05 a	69.51	74.87 b	61.99
T 5	73.92 ab	69.00	75.81 ab	60.95
T 6	67.63 c	68.64	73.73 b	65.29
T 7	68.66 bc	67.13	78.35 a	62.54
l.s.d. (P = 0.05)	5.36	NS	2.70	NS
		Percentage marketable yield		
T 1	89.63	77.07 b	88.56 ab	74.11 c
T 2	89.45	80.87 a	87.49 b	78.72 b
T 3	89.91	81.66 a	89.57 a	84.17 a
l.s.d. (P = 0.05)	NS	3.46	1.54	3.88
T 4	91.07	80.56	87.45 b	77.39
T 5	90.88	79.13	88.81 ab	78.25
T 6	87.62	80.68	87.82 b	81.48
T 7	89.10	79.10	90.08 a	78.88
l.s.d. (P = 0.05)	NS	NS	1.78	NS

Table 7. Number of fruit and average fruit weight of main treatment effects of experiments 1, 2, 3 and 4.

Means within columns followed by a common letter are not significantly different at P = 0.05.
NS = F test not significant.

Treatments	Expt. 1	Expt. 2	Expt. 3	Expt. 4
		Number of fruit		
T 1	249	376	369	400 c
T 2	249	388	386	447 b
T 3	254	407	372	477 a
l.s.d. (P = 0.05)	NS	NS	NS	26
T 4	254	403	377	447
T 5	242	390	372	441
T 6	253	383	378	438
T 7	255	386	376	438
l.s.d. (P = 0.05)	NS	NS	NS	NS
		Average fruit weight (gm)		
T 1	191	145 b	118	135
T 2	193	149 a	117	139
T 3	193	149 a	116	138
l.s.d. (P = 0.05)	NS	3.6	NS	NS
T 4	184 b	145	117	132 b
T 5	195 a	147	117	138 a
T 6	196 a	150	117	138 a
T 7	195 a	148	117	142 a
l.s.d. (P = 0.05)	6	NS	NS	5.6

Table 8. Percentage small [A], percentage medium [A], percentage large [A] and percentage extra large [A] fruit of main treatment effects of experiments 1, 2, 3 and 4.

Means within columns followed by a common letter are not significantly different at P = 0.05.
NS = F test not significant.

[A] small = 50 to 60 mm diameter; medium = 60 to 75 mm diameter.
large = 75 to 80 mm diameter; extra large = > 80 mm diameter.

Treatments	Expt. 1	Expt. 2	Expt. 3	Expt. 4
	Percentage small fruit (50 to 60 mm)			
T 1	2.34	11.19	25.24	15.92
T 2	2.50	9.43	25.28	14.53
T 3	2.26	10.24	25.91	15.08
l.s.d. (P = 0.05)	NS	NS	NS	NS
T 4	3.42 a	10.66	25.66	17.60 a
T 5	1.89 b	10.57	25.24	14.96 ab
T 6	2.13 b	9.72	25.73	15.25 ab
T 7	2.01 b	10.21	25.29	12.89 b
l.s.d. (P = 0.05)	0.73	NS	NS	2.98
	Percentage medium fruit (60 to 75 mm)			
T 1	34.24	49.20	50.73	56.81 a
T 2	31.59	47.26	50.66	53.62 b
T 3	31.40	46.07	51.21	51.90 b
l.s.d. (P = 0.05)	NS	NS	NS	2.50
T 4	38.80 a	50.86 a	50.53	56.98 a
T 5	31.28 b	46.46 b	51.29	53.66 b
T 6	28.77 b	45.95 b	50.56	53.31 b
T 7	30.79 b	46.76 b	51.09	52.49 b
l.s.d. (P = 0.05)	4.72	3.00	NS	2.89
	Percentage large fruit (75 to 80 mm)			
T 1	40.97	30.53	14.99	21.49 b
T 2	41.31	32.55	16.23	24.58 ab
T 3	41.95	32.62	14.75	25.91 a
l.s.d. (P = 0.05)	NS	NS	NS	3.15
T 4	38.27 b	28.92 b	14.72	20.18 b
T 5	42.84 a	32.79 a	15.14	24.68 a
T 6	43.16 a	33.71 a	15.16	24.70 a
T 7	41.37 a	32.18 a	16.28	26.42 a
l.s.d. (P = 0.05)	2.99	2.90	NS	3.64
	Percentage extra large fruit (> 80 mm)			
T 1	22.46	8.01	3.79	4.08
T 2	24.56	9.80	2.93	5.61
T 3	24.38	10.19	2.72	5.63
l.s.d. (P = 0.05)	NS	NS	NS	NS
T 4	19.48 b	8.52	3.65	3.35 b
T 5	23.99 ab	9.29	3.13	4.99 ab
T 6	25.92 a	9.72	3.24	5.23 ab
T 7	25.81 a	9.89	2.55	6.86 a
l.s.d. (P = 0.05)	4.64	NS	NS	1.93

Titratable acidity

The only significant differences for titratable acidity occurred in the early treatments in experiment 4 where T1 was significantly (P<0.05) greater than T2 or T3 which were not significantly different from each other (Table 9). The late irrigation treatments did not cause differences in any of the 4 experiments.

Total soluble solids

For total soluble solids the only significant differences in the early irrigation treatments also occurred in experiment 4. Treatment T1 was significantly (P<0.05) greater than T2 which in turn was significantly (P<0.05) greater than T3 (Table 9). The late irrigation treatments caused significant differences in experiments 1 and 4. In these experiments, T4 was significantly (P<0.05) greater than the other 3 treatments (Table 9).

Table 9. Titratable acidity and total soluble solids (^{0} Brix) of main treatment effects of experiments 1, 2, 3 and 4.

Means within columns followed by a common letter are not significantly different at P = 0.05. NS = F test not significant.

Treatments	Expt. 1	Expt. 2	Expt. 3	Expt. 4
		Titratable acidity		
T 1	6.59	6.82	7.07	7.42 a
T 2	6.56	6.78	7.00	6.84 b
T 3	6.49	6.92	6.96	6.84 b
l.s.d. (P = 0.05)	NS	NS	NS	0.33
T 4	6.65	6.68	6.99	7.21
T 5	6.41	6.83	7.13	7.08
T 6	6.53	7.05	7.03	6.82
T 7	6.60	6.78	6.90	7.03
l.s.d. (P = 0.05)	NS	NS	NS	NS
		Total soluble solids (^{0} Brix)		
T 1	4.51	4.34	3.57	4.12 a
T 2	4.43	4.25	3.62	4.00 b
T 3	4.43	4.23	3.51	3.85 c
l.s.d. (P = 0.05)	NS	NS	NS	0.10
T 4	4.69 a	4.31	3.63	4.158 a
T 5	4.41 b	4.31	3.55	4.036 b
T 6	4.40 b	4.24	3.51	3.936 bc
T 7	4.31 b	4.23	3.59	3.835 c
l.s.d. (P = 0.05)	0.23	NS	NS	0.116

Interactions

For the 4 experiments, there were very few significant differences in the interactions between the early and late irrigation treatments for any of the parameters measured and, therefore, no results have been presented.

Discussion

This study highlighted the problems associated with irrigation experiments, particularly when there is no control over natural irrigation i.e. rain. Of the 4 experiments, only experiment 1 did not receive any rainfall during the life of the crop.

Total yield, marketable yield, yield of first grade fruit.

For the early irrigation treatments, yield of the above 3 parameters was reduced below 1.0 ET (100% ET) in experiment 4 and below 0.50 ET (50% ET) in experiment 2. There was no response to early irrigation in experiment 1 but in this case the lowest early treatment was 50% ET. Heavy rainfall negated the early treatments in experiment 3 and this would explain the lack of response to these treatments in this experiment.

Considering the late treatments, there was no response of yield parameters (to irrigation treatment) in any of the 4 experiments. Experiments 2 and 4 received heavy rainfall during this stage and this would have overridden the effect of low water applications. A point to consider, however, is that the late irrigation treatments were primarily to test the effect of different water regimes on flavour attributes such as total soluble solids and titratable acidity. They were commenced 2 weeks prior to first harvest and continued during the harvest period which was 4 to 5 weeks. Their

effect on yield parameters could be expected to be minimal as was shown in experiments 1 and 3.

Percentage first grade fruit, percentage marketable yield

In experiment 4, 100% ET in the early treatments resulted in the highest percentage first grade fruit and the highest percentage marketable yield. This same treatment tended to give the highest percentage marketable yield for experiments 2 and 3. The result for late irrigation treatments with these 2 parameters was inconclusive.

Number of fruit, average fruit weight

The increased yield as a result of the early 100% ET treatment in experiment 4 was due to an increased number of fruit and not average fruit weight which was unaffected by the early irrigation treatments. Reduced average fruit weight occurred in the early 25% ET treatment in experiment 2 and in the late 25% ET treatment in experiments 1 and 4

Percentage small, percentage medium, percentage large, percentage extra large fruit.

Only in experiment 4 did the reduced early stage irrigation applications affect percentage of the different fruit sizes with the 25% ET treatment resulting in a greater percentage of medium and a smaller percentage of large fruit. The late 25% ET irrigation treatment had a more pronounced effect on the above parameters over most of the experiments. A greater percentage of small and medium sizes and a corresponding lower percentage of the large and extra large sizes occurred in this treatment in experiments 1, 2 and 4. No differences occurred in experiment 3 which had received heavy rainfall during the early stages of the experiment. The 50% ET, 75% ET and 100% ET late stage treatments did not affect fruit size distribution.

Titratable acidity, total soluble solids

The effect of reduced water application on these 2 parameters was minimal. Total soluble solids (^{0} Brix) of fruit increased slightly in experiments 1 and 4 as less irrigation water was applied. Titratable acidity was increased under the 25% ET early stage irrigation regime in experiment 4. In all other cases there were no differences as irrigation was varied.

Conclusion

The results of this study varied with the different experiments. Trends were not consistent between experiments even though the same treatments were applied each time. Rainfall which was quite heavy at different times throughout the study obviously had a big impact on the results. The conclusions from this study have been drawn from a combination of the four experiments. Some results have been ignored in an attempt to come to a conclusive result.

Considering the early treatment stage from flowering until 2 weeks prior to harvest, restrictions to irrigation below 100% ET caused losses in total yield, marketable yield and yield of first grade fruit. The 100% ET treatment resulted in the highest percentage first grade fruit and highest percentage marketable fruit.

The late irrigation treatments from 2 weeks prior to harvest and through the harvest period had little effect. The 25% ET treatment reduced average fruit weight and this was reflected in the percentages of the different fruit sizes. A greater percentage of small and medium sized fruit and a corresponding lower percentage of large and extra large fruit occurred in this treatment. For the late stage irrigation treatments, there was no advantage to increasing irrigation above 50% ET.

The effectiveness of late applied water restrictions in boosting total soluble solids was minimal. Total soluble solids increased only slightly with reduced water application and this practice could not be recommended. There were greater differences in total soluble solids content between seasons than occurred as a result of varying irrigation regimes. Breeding for improved total soluble solids content of tomato fruit must remain a priority.