PC 23a
final report

WELSH COLLEGE OF HORTICULTURE

FINAL REPORT 1991 - PC/23a GROWTH MEDIA MANAGEMENT FOR MAIN CROP TOMATOES

TRIAL AIMS

1. To investigate the potential for the production of tomatoes in rockwool using re-cycled nutrient solution.

2. To investigate the effects on production of a "Low Nitrogen" trial feed formulation produced by ICI.

3. To compare the fertiliser usage in conventional rockwool and NFT systems with that in a rockwool system using re-cycled solution.

4. To monitor the effect of the four treatments on fruit yield and quality.

Facilities Used:

Two Frampton Q22 houses, each 2.3m to the eaves each with floor dimensions, 96' x 44'.

Computer control of the environment was operational in both units and the nutrient monitoring and dilution provided by minimometer and solor equipment.

CROP CULTURE

Cultivar: Liberto

Plants: Raised by Crysatal Heart and delivered 12th December 1990 as 35 day old plants.

Planting Date: NFT at delivery

All Rockwool treatments at first anthesis.

Environmental Control:

Temperature: Planting to end of April. ADAS blueprint

April onwards: Night 16`c
Day 17`c
Vent 19`c

Relative Humidity: Target 78%

CO2 Enrichment: By direct combustion to give 1000vpm

Planting to early April

Pollination: First anthesis to mid-January by electric bees, daily.

From mid-January by bumble bees.

Harvesting: 4 - 6 times per week; all fruit graded to EEC standards.

TREATMENTS APPLIED

1. NFT

The system was set up using 10" troughs to give a slope of 1 in 75 and a flow rate of 10 1/min. The row length was 96'.

The nutrition programme followed ICI recommendations using a conventional solufeed formulation. Appendix 1.

Intermitten solution flow was used for the first two weeks after planting then continuous flow used until the end of the crop. Aaterra was added to the circulating solution (40g/10001) three times and the circulating solution replaced once at first pick.

2. Rockwool "excess solution to waste"

Plants were planted on Grodan HP slabs during the third week of December.

The nutrition programme followed ICI recommendations using a conventional solufeed formulation. Appendix I.

Irrigation was supplied initially on a time basis then in response to the light integral.

Planting late December 150 ml/plant daily
Late December - mid January 250 ml/plant daily
Mid-January - mid-February 375 ml/plant daily
Mid-February to end of April, 7 cycles daily totalling 1.2 litres plus 170ml every 55 w/m2.

End of April onwards, 7 cycles daily totalling 1.4 1 plus 250 ml every 55 w/m2.

3. Rockwool "excess solution to waste" using a low Nitrogen Feed formulation

This treatment was set up exactly as for the treatment using the conventional solufeed formulation with "low Nitrogen solufeed" being substituted from early February. For 25kg of conventional solufeed a cocktail of 25 kg low "N" formulation : 6.25kg conventional solufeed has been substituted.

4. Rockwool using conventional solufeed formulation with the run-off collected and re-cycled

Wrapped rockwool slabs were placed on narrow polystyrene boards (4" x 1") and loosely overwrapped with black/white twin extruded polythene. After wetting up, slabs were slit and the run-off collected at the end of each 96' row. Ground profiling provided a slope of 1 in 100 to facilitate this collection. Collected run-off was returned to the mixing tank at intervals determined by a float switch controlling the pump. Irrigation frequency was the same as for the run-off to waste systems. The nutrition programme used was also the same as for the conventional run to waste system (Treatment 2).

In all systems slab samples were taken for analysis bi-monthly.
All rockwool sysems had Filex added once during each March.

RESULTS

Each of the treatments supplied had a small effect on the total yield of graded fruit "Table 1". In both 1990 and 1991 seasons the relationship between the respective yields is the same suggesting that a low Nitrogen regime is at least as good as the conventional feed regimes and systems of production, but that production from plants grown in rockwool with the run-off re-cycled needs further investigation before implementation. Control of slab conductivity in the Rockwool re-cycle system was less of a problem in 1991 cn 1990 but magnesium deficiency occurred in all Rockwool treatments during late April. Plant losses, approximately 5%, were more severe in the re-cycling Rockwood system and the NFT system then the "run to waste" systems.

The results of the bi-monthly nutrient analyses are to be found in Appendix 2.

As in 1990 the fertiliser usage was markedly reduced by implementing a re-cyling system "Table 2".

Fruit size, "Table 3" and fruit quality "Table 4" were unaffected by any of the treatments but fruit sugars were higher in fruits taken from the low nitrogen feed and customer preference was for the flavour of these fruit.

TABLE 1 THE EFFECT OF GROWTH MEDIA REGIME ON MONTHLY TOMATO YIELD 1991

Monthly Yield in pounds (Class I and II only) from 420 plants

	Low Nitrogen	Rockwool Re-circulation	Rockwool to waste	NFT
February	4½	2½	8	
March	521	565	555	418
April	1022	902	934½	1062
May	1394	1181½	1211½	1462½
June	1664½	1432	1580½	1552
July	1876½	1593½	1884½	1814½
August	1568	1398	1649	1559
September	1413	1157	1408	1473
October	912	1036	761	1066
TOTAL	10375	9270	9991	10407
TOTAL 1990	**10163**	**9273**	**9323**	**9838**
AVERAGE TOTAL YIELD	**10269**	**9272**	**9657**	**10122**

Plant density 1990 12,000/acre
1991 11,200/acre

Side shoots taken on every third plant in early Marcn

TABLE 2

FERTILIZER USAGE (0.05 ACRES) KILOGRAMS

	Calcium Nitrate		Solufeed	
	Pure	Norsk (Prilled)	Normal	Low N.
Rockwool 'to waste'	197	190	550	-
N.F.T.	125	45	250	-
Rockwool 'recycle'	162	108	225	-
Rockwool (Low Nitrogen Regime)	169	266	185	575

Table 3 The effect of the growth media regime of fruit size

	% Class I				
	35 - 40	40 - 47	47 - 57	57 - 67	mm
NFT	7	23	44	26	
Rockwool 'to waste'	13	32	41	15	
Rockwool 'Recycle'	8	30	45	17	
Rockwool Low N Feed regime	8	32	42	17	

Table 4 The effect of Growth media regime of fruit quality and yield (pounds)

	% Class I	% Class II	Total Yield
NFT	92	8	10407
Rockwool 'to waste'	91	9	9991
Rockwool 'Recycle'	88	12	9270
Rockwool Low N Regime	92	8	10375

Conclusion

Recycling of nutrient solutions in NFT and Rockwool systems significantly reduces fertilizer use and run-off into the ground. A small yield loss may be noted in this system using rockwool but the yield from NFT plants compares favourably with a rockwool 'run to waste' system. Root loss was not a particular problem in either recycling system in 1991 but there was a significant loss (5%) of plants due to basal stem rotting.

The use of a 'low nitrogen' feed regime produces a slight increase in yield compared with a conventional 'solufeed' nutrient regime with no detriment to fruit quality and size distribution. Results from the use of this feed regime have been consistent over two seasons indicating that this may be an easily implemented treatment within existing cultural techniques which will be of benefit to both the grower and the environment.

Appendix I

Nutrient Programmes

Site Water Analysis (Mains Supply)

pH 7.07
Conductivity 97 usiemens

	mg/1		mg/1
Nitrate	0.3	Sulphate	11.7
Phosphorus	< 0.1	Iron	0.78
Potassium	< 1	Manganese	< 0.1
Calcium	9	Copper	< 0.1
Magnesium	1.0	Zinc	0.49
Sodium	13.4	Boron	0.07
Chloride	11.8		

1. NFT

First truss flowering to three weeks before first harvest	Solution EC 5000 3000 in stages	Solution pH 5.5 - 6	**TANK A** 25kg Solufeed **TANK B** 31kg CA.Nit. 21kg KNO3 reduce to 21kg CA.Nit. 4kg KNO3
From first harvest	2,300 - 2,500	5.5 - 6	**TANK A** 25kg Solufeed **TANK B** 17kg C. Nit

- pH controlled by acid injection

- Iron Chelate added to Tank A

- Prilled Calcium Nitrate used in a 25 : 75 ratio with pure Calcium Nitrate from early July.

2. Low Nitrogen Regime (Rockwool)

	Solution EC	Solution pH	
First truss flowering to three weeks before first harvest	5000	5.5 - 6	TANK A 25kg Solufeed *
	3000		TANK B 34kg Ca.Nit. 15kg KNO3 reduce to 19kg CA.Nit. 4kg KNO3
From first harvest	2300 - 2500	5.5 - 6	TANK A 25kg Solufeed * TANK B 19kg Ca.Nit.

Pure and Prilled Calcium nitrate used in a 40 : 60 ratio.

* Low N solufeed used from 15th January with the addition of 6.5kg Normal solufeed per 25kg.

3. Rockwool

	Solution EC	Solution pH	
First Anthesis to just before first harvest	3500	5.5	TANK A 25kg Solufeed TANK B 34kg Ca.Nit. 15kg KNO3 reduce to 16kg Ca.Nit. 5kg KNO3
Just before first harvest onwards	2300	5.5	TANK A 25kg Solufeed TANK B 16.1kg Ca.Nit.

- pH control by Acid injection

- Pure and Prilled Calcium Nitrate used in a 40 : 60 ratio.

4. Rockwool Recycling "run off"

Nutrition programme as for Rockwool "to waste" system.

APPENDIX II

ANALYSIS DATA LOW NITROGEN FEED SLAB ANALYSIS

Date	pH	Conductivity µS 1	NH_4^+ N mg/l	NO_3^- N mg/l	P mg/l	K mg/l	Ca mg/l	Mg mg/l	Na mg/l	CL mg/l	SO_4^{2-} as.S mg/l	Fe mg/l	Mn mg/l	Cu mg/l	Zn mg/l	B mg/l
11.1.91	5.7	5610	2.0	619	46	913	492	50	37	110	67	4.2	0.62	0.36	1.13	0.39
1.2.91	6.0	5770	7.0	704	5	921	610	19	42	-	-	2.02	0.32	0.20	0.51	0.16
13.2.91	5.1	5190	0.1	531.4	46	1062	380	65	42	137	60	3.59	0.94	0.38	0.94	0.51
26.2.91	5.5	4450	2.6	290	49	886	279	70	34	533	92	2.47	0.97	0.36	0.96	0.53
15.3.91	5.0	3290	2.7	189	43	602	210	59	30	470	77	1.79	0.77	0.36	0.84	0.47
27.3.91	5.0	4300	0.8	284	63	599	447	90	35	622	80	3.83	1.07	0.47	1.27	0.70
9.4.91	5.5	3760	0.3	108	55	870	142	83	40	650	109	2.57	1.27	0.16	1.26	0.59
23.4.91	5.7	4160	2.0	204	58	806	352	58	42	-	-	2.47	0.72	0.36	0.99	0.55
8.5.91	5.5	3490	2.8	177	48	651	241	60	34	-	-	2.18	0.72	0.37	0.93	0.4
23.5.91	5.9	3540	4.4	479	19	476	316	61	35	-	-	1.58	0.68	0.34	0.81	0.44
6.6.91	5.3	2940	6.5	180	64	466	232	52	28	394	38	1.75	0.91	0.30	0.78	0.40
18.6.91	5.3	3200	9.0	306	24	249	468	26	21	242	50	0.96	0.27	0.15	0.42	0.21
3.7.91	6.3	2250	0.6	55.0	31	351	145	43	36	431	70	1.54	0.26	0.24	0.66	0.12
18.7.91	5.8	4280	2.8	240	45	728	361	72	47	630	82	2.55	0.69	0.4	1.01	0.59
8.8.91	5.2	3410	2.1	184	47	642	253	44	34	503	69	1.28	0.58	0.3	0.65	0.31

APPENDIX V

ANALYSIS DATA NFT SOLUTION ANALYSIS

Date	pH	Conductivity µS 1	NH_4^+ N mg/l	NO_3^- N mg/l	P mg/l	K mg/l	Ca mg/l	Mg mg/l	Na mg/l	CL mg/l	SO_4^{2-} as.S mg/l	Fe mg/l	Mn mg/l	Cu mg/l	Zn mg/l	B mg/l
11.1.91	6.0	4830	< 1	477	78	786	417	55	35	122	101	2.75	0.19	0.33	1.54	0.40
1.2.91	5.8	4990	< 1	475	72	958	363	86	43	-	-	2.12	0.32	0.58	1.41	0.80
13.2.91	6.1	4400	0.1	406	22	780	310	83	55	185	103	0.82	0.10	0.33	0.94	0.64
26.2.91	6.1	3650	0.1	355	55	657	252	65	62	172	84	1.21	0.10	0.19	0.78	0.56
15.3.91	6.1	2500	< 0.1	300	35	374	153	35	65	138	48	0.73	<0.1	0.11	0.33	0.34
27.3.91	6.2	2370	< 0.1	247	37	223	116	41	60	62	64	4.43	0.18	0.23	0.64	0.46
9.4.91	6.1	2430	< 0.1	194	7	431	149	57	37	103	82	5.53	0.14	0.34	0.92	0.43
23.4.91	6.2	2530	0.9	232	49	159	333	47	64	-	-	9.34	<0.1	0.42	1.05	0.33
8.5.91	6.1	2390	0.8	204	23	431	144	47	36	-	-	3.9	0.33	0.33	1.16	0.30
23.5.91	5.9	2550	0.9	215	33	508	139	46	26	-	-	3.15	0.78	0.32	0.75	0.16
6.6.91	5.7	2410	0.5	232	33	283	254	31	35	71	65	1.22	0.10	0.23	0.53	0.09
18.6.91	6.0	2560	0.1	236	51	344	254	43	37	84	68	4.52	0.55	0.33	0.93	0.27
3.7.91	6.1	2640	0.4	219	66	438	177	49	50	133	74	1.40	0.10	0.22	0.65	0.22
18.7.91	5.7	2560	0.3	226	40	569	150	43	26	93	76	4.3	0.72	0.3	0.78	0.45
8.8.91	6.0	2450	0.3	264	36	129	332	28	40	58	35	4.65	1.10	0.23	0.53	0.05

APPENDIX III

ANALYSIS DATA — ROCKWOOL 'TO WASTE' SLAB ANALYSIS

Date	pH	Conductivity µS 1	NH_4^+ N mg/l	NO_3^- N mg/l	P mg/l	K mg/l	Ca mg/l	Mg mg/l	Na mg/l	CL mg/l	SO_4^{2-} as.S mg/l	Fe mg/l	Mn mg/l	Cu mg/l	Zn mg/l	B mg/l
11.1.91	5.3	5870	<1	650	42	1069	460	57	40	122	75	5.0	0.76	0.32	1.03	0.46
1.2.91	5.4	6760	4.0	830	42	1110	660	49	47	-	-	3.56	0.62	0.42	0.94	0.43
13.2.91	4.5	6020	8.4	759	15	839	708	36	39	87	34	3.02	0.32	0.15	0.49	0.21
26.2.91	5.0	5000	3.8	506	49	1075	366	71	40	144	110	2.78	1.09	0.42	1.08	0.60
15.3.91	5.6	5230	3.3	522	59	1100	344	93	47	153	138	2.67	1.04	0.47	1.22	0.59
27.3.91	5.4	3490	5.1	372	27	492	402	45	24	95	82	1.68	0.61	0.28	0.67	0.39
9.4.91	5.1	4350	0.3	352	118	1030	212	86	46	163	135	3.06	1.38	0.55	1.37	0.65
23.4.91	6.0	5080	1.8	505	47	801	547	77	52	-	-	4.22	0.96	0.55	1.42	0.66
8.5.91	5.1	4500	2.0	463	84	880	350	76	44	-	-	3.19	1.18	0.57	1.43	0.56
23.5.91	5.9	5100	0.8	217	56	923	399	109	63	-	-	3.45	0.92	0.78	1.84	0.83
6.6.91	5.2	2700	7.6	273	21	336	279	36	23	74	58	1.50	0.64	0.24	0.58	0.23
18.6.91	5.8	3100	7.4	311	38	401	357	40	27	85	82	1.47	0.59	0.27	0.68	0.34
3.7.91	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
18.7.91	5.5	3010	2.9	362	21	191	482	26	25	65	38	1.38	0.27	0.19	0.46	0.20
8.8.91	5.8	4010	1.1	357	75	911	249	75	48	167	140	3.35	1.20	0.63	1.54	0.54

APPENDIX IV

ANALYSIS DATA ROCKWOOL RECYCLE SLAB ANALYSIS

Date	pH	Conductivity µS 1	NH_4^+ N mg/l	NO_3^- N mg/l	P mg/l	K mg/l	Ca mg/l	Mg mg/l	Na mg/l	CL mg/l	SO_4^{2-} as.S mg/l	Fe mg/l	Mn mg/l	Cu mg/l	Zn mg/l	B mg/l
11.1.91	5.5	6060	2.0	653	76	1047	524	62	40	122	98	4.78	0.81	0.43	1.38	0.51
1.2.91	6.0	7740	<1	891	33	1354	708	71	77	-	-	6.51	0.47	0.53	1.60	0.60
13.2.91	6.2	6800	<0.1	798	16	1115	710	57	73	155	46	5.86	0.29	0.30	1.09	0.35
26.2.91	6.2	4450	0.8	539	18	582	530	30	45	77	24	1.94	0.11	0.12	0.76	0.13
15.3.91	5.7	4000	0.5	529	23	449	463	24	42	41	14	0.83	<0.1	0.09	0.61	0.07
27.3.91	5.9	2560	< 0.1	239	40	415	253	47	29	90	80	5.56	0.88	0.30	1.04	0.32
9.4.91	6.0	3090	< 0.1	272	55	451	283	67	46	122	103	8.3	1.32	0.4	1.41	0.4
23.4.91	6.2	3320	1.1	241	36	602	199	73	59	-	-	13.2	0.92	0.57	1.74	0.67
8.5.91	5.6	3150	1.0	386	41	376	345	49	43	-	-	5.34	1.09	0.39	1.18	0.27
23.5.91	6.3	3000	0.8	218	60	497	196	75	66			3.45	0.47	0.61	1.59	0.55
6.6.91	5.8	3080	0.7	237	47	654	161	64	47	137	113	4.49	0.70	0.49	1.36	0.56
18.6.91	5.6	3000	0.3	273	52	527	255	49	33	106	85	4.48	1.02	0.37	1.08	0.44
3.7.91	4.9	3600	2.5	474	4	35	705	17	23	48	31	2.14	0.32	0.14	0.65	<0.02
18.7.91	6.0	3030	1,4	327	11	286	422	36	32	92	53	2.3	0.31	0.27	0.88	0.33
8.8.91	6.2	3050	0.5	417	2	12	560	6	20	32	10	6.93	0.12	0.09	0.49	0.02