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LEGOLA (PTY) LTD

UNIDO CONTRACT: 2000/192

PROJECT NO: MP/BOT/98/081

FINAL REPORT

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PREPARED BY: G.J. CHIDAMWOYO

INTRODUCTION:

The purpose of these trials was to demonstrate the effectiveness of several alternatives to the use of methylbromite as a soil fumigant in horticulture [e.g. in tomatoes]

The trials were divided into two; the first year, trials were run on soilless, biofumigation, diazomet, methylbromite and the control techniques. At the end of the season, data and samples collected during the season would be analysed thoroughly and a possible alternative selected. The selected alternative will be tried on full scale in the second and final year.

Based on the costs of production, the total yield and quality of crop produced, the soilless technique produced the best results- hence the need to try it on full scale, in the 2001/2002 season.

Results from the final trials were carried out on 900 square meters of the soilless treatment and 900 square meters of control. All these demonstration plots were monitored in cooperation with international and national experts for identification of plant pathogens, collection of necessary data and samples for analysis.

BEFORE PLANTING:

1.1.

a. General Climatic Conditions:

Hot and humid in summer ,warm to cold in winter with chances of mild to heavy frost.

b. Temperature And rainfall Data:[see temperature and rainfall graphs attached].

The temperature is recorded in degrees celcius and rainfall in millimeters.

Month	Minlimum average temperature	Rainfall [mm]
October	23.2	16
November	22.2	206
December	22.5	92
January	24.3	16
February	24.0	12
March	22.8	4
April	19.1	39
May	12.8	0
June	9.1	20
July	2.0	0
TOTAL RAINFALL		405

c. History Of Plot:

The land was being cropped since 1994.

Season	Crop[s] Planted	Variety Planted
1998/1999	rape and butternuts	English giant and waltham
1999/2000	tomato and cabbage	9006 and congestador
2000/2001	tomato	H.T.X.
2001/2002	tomatoes greenpeppers	9006 capistirano

d. Diseases And Pests Incidence:

Season	Diseases and Pests Identified
1998/1999	diamond back moth larvae.
1999/2000	fruit fly , blights and diamond back moth larvae.
2000/2001	red spider mites & leafminer
2001/2002	leaf blights,bollworms. red spider mites & leafminer

e. Fertilisation Plan:

Before transplanting	After transplanting [top dressing]
21 kilograms [126 kgs.]4.3.4.	800 kgs Ammonium sulphate
33 kilograms. [198 kgs.] S.S.P. [Singlesuperphosphate]	170 kgs.K.N.O3[potassium nitrate] [fertiliser was applied between 3 & 12weeks as split applications]

A total of 126 kilogramms 4: 3:4 was applied in all the six plots.

A total of 198 kilogramms Singlesuperphosphate was applied in all the six plots.

1.2. Variables To Be Measured

a. Soil Analysis; samples were send to Gaborone on 27/11/2001.

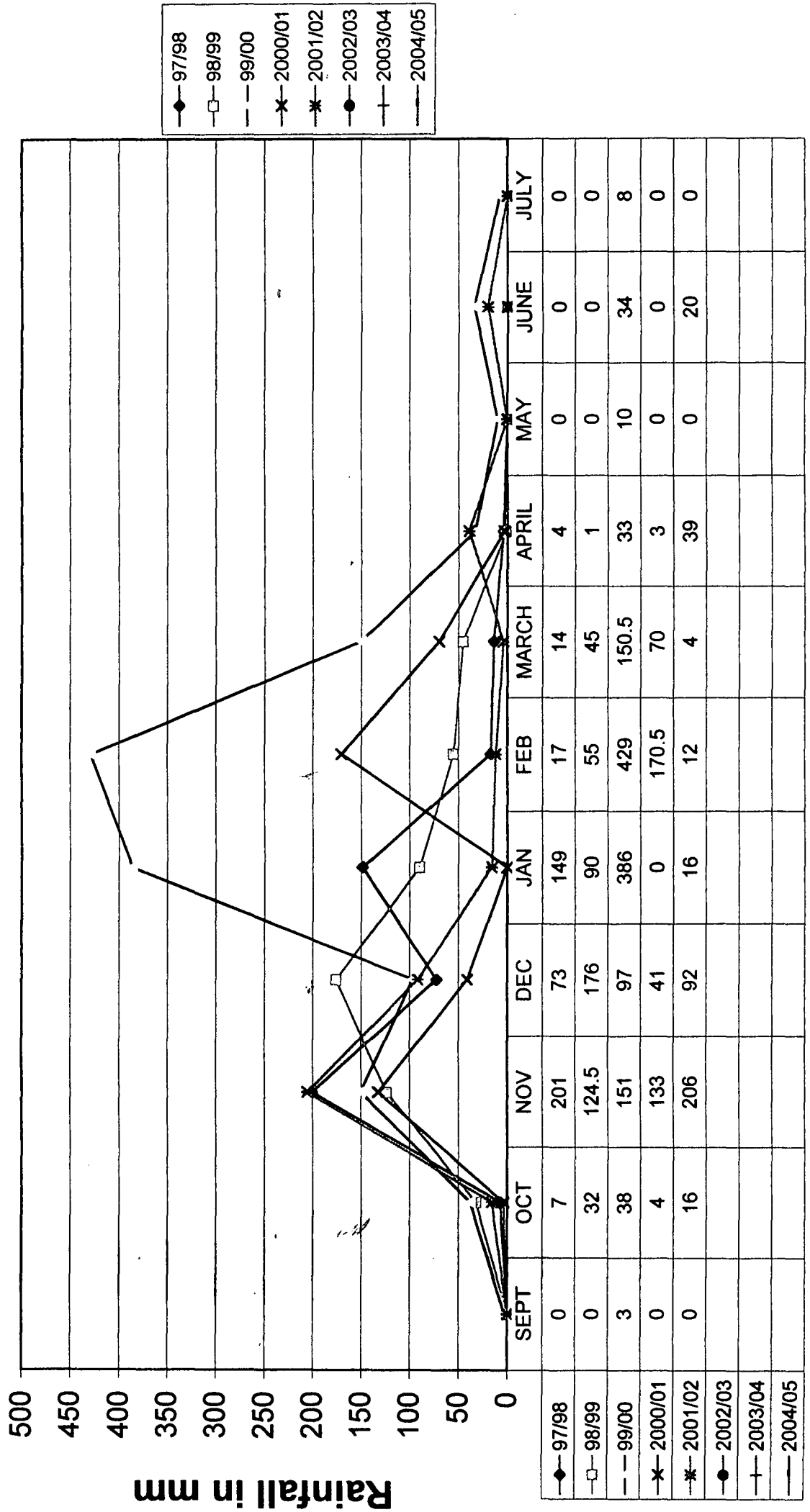
b. Water samples were sand to Gaborone on 27/11/2001 for analysis.

DAILY TEMPERATURE RECORD

MONTH DATE	2001		2002		2001		2002		2001		2002		2001		2002		2001		2002	
	SEPT.		OCT.		NOV.		DEC.		JAN.		FEB.		MARCH		APRIL		MAY		JUNE	
	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.
1	22	29	22	29	24	33	22	27	22	29	26	35	25	31	21	28	19	28	17	25
2	23	30	21	29	23	32	22	28	21	29	25	33	25	35	21	29	16	26	17	25
3	23	29	21	29	21	34	23	29	21	29	23	33	25	35	21	30	15	27	18	20
4	23	31	24	32	21	34	23	31	24	32	24	33	25	35	20	29	15	27	10	17
5	22	27	24	32	25	34	22	27	24	32	25	35	24	32	20	29	15	27	10	18
6	22	31	24	32	25	35	21	31	24	32	26	36	24	32	21	29	15	27	10	17
7	22	33	24	33	24	35	22	33	24	33	27	37	23	34	21	29	14	26	15	20
8	23	32	25	35	22	34	22	31	25	35	23	35	25	35	20	31	9	22	15	20
9	21	31	25	34	21	24	21	31	25	34	24	33	23	31	30	21	9	20	14	20
10	21	32	24	33	20	23	21	32	24	33	22	33	23	31	19	30	10	21	13	22
11	23	34	24	33	20	25	23	34	24	33	22	33	23	31	21	30	10	22	11	21
12	24	31	25	35	20	31	24	31	25	35	24	35	22	33	21	30	10	21	12	21
13	22	30	25	35	22	29	22	30	25	35	23	35	23	34	20	29	12	22	12	22
14	24	29	25	35	22	31	24	29	25	35	25	37	25	31	20	27	11	23	15	24
15	23	31	24	31	21	28	23	31	24	31	26	36	24	33	20	25	11	25	8	21
16	23	31	20	33	22	29	23	31	24	33	27	32	22	32	18	24	12	23	10	20
17	23	31	24	37	22	28	23	31	25	35	27	33	22	29	15	23	12	22	9	18
18	24	32	25	40	22	28	24	32	24	34	23	34	22	30	17	25	11	24	10	20
19	23	34	26	37	22	29	23	34	25	35	21	29	24	33	17	27	11	23	9	20
20	24	34	22	31	21	32	24	34	24	35	21	29	22	35	19	30	13	24	8	15
21	26	36	21	23	23	31	25	36	24	35	22	31	23	34	18	29	15	22	9	11
22	24	32	20	25	23	31	24	32	25	33	24	32	23	33	18	27	14	25	9	11
23	23	32	21	32	22	32	23	32	25	33	24	33	24	32	19	27	12	27	2	28
24	22	32	22	33	23	33	22	32	24	34	23	32	23	31	18	27	14	29	2	32
25	24	33	22	33	23	31	23	33	26	35	23	33	22	31	18	27	13	24	0	32
26	24	34	23	33	22	32	24	34	25	33	23	31	21	29	17	27	12	23	2	21
27	22	32	23	30	24	31	22	32	25	32	24	34	20	30	16	27	13	28	1	27
28	21	34	24	29	21	30	21	34	25	33	25	32	20	31	16	26	17	25	2	28
29	21	21	22	28	21	25	21	21	25	31			20	31	16	27	13	24	2	29
30	20	22	23	32	23	27	20	22	25	33			22	32	15	27	13	26	2	28
31			24	33			22	34	26	35			22	32			11	20		

The above table is a daily record of room temperatures and is from the beginning of every month until the end. All the temperature and rainfall readings are recorded at 0800 hours.
 The red color on the 8 th. May 2002 of a minimum temperature of 9 and maximum 22, marked the start of frost. The growing parts were killed and plants stopped growing.

LEGOLA ANNUAL RAINFALL



Months

2.DURING THE TREATMENT:

2.1 Information needed.

a. Watering.

The amount of water applied is recorded in hours.

Month	Irrigation hours
November	9
December	15
January	48
February	54
March	36
April	48
May	78
June	12
Total Irrigation hrs	298

- b. Treatment dosage. sand - 96 tones.
raw poultry manure - 4.5 tones

c. Characteristics of materials used.

type of fertilizer	N.	P.	K.(kgs. Per 50 kg. Bag)
4.3.4.	8kgs.	4.5kgs.	8kgs.
S.S.P.	0	5.2kgs.	0

The raw poultry manure, soil and water samples were send for analysis on the 26/11/2001.

d. Duration of treatment.

Twenty-four [24] days was allowed between treatment of plots and transplanting.

GENERAL COMMENTS:

Rainfall:

Heavy rains in November delayed planting of the plots because trucks delivering sand could not access the farm roads as the trucks were getting stuck into the mud.

The Soilless Plot Observations:

High initial input costs: A total of 96 tones of river sand was transported at a cost of over P4000.00 for the three plots. This cost could have gone well beyond P4000.00 had we not planted the crop on the sand ridges.

Difficult crop establishment;[high plant mortality]

After transplanting ,there is more deaths of seedlings because of the poor moisture holding capacity of sand and also temperatures are quite high during this time of the season.

Suitability:

On large scale this not a practical method of crop production because of the high labour costs required at land preparation ,high transport costs for importing sand into the farm and also it is not realistic to put at least 20 cm.layer of sand on one hectare of land.

3.DURING CULTIVATION

3.1. a.Pests Identified:

*There was a **serious outbreak of the elegant grasshopper**. This is a type of a locust which feeds on the vegetative matter of the plant and these locusts move in swarms of hundreds,so if unnoticed, they can clean a hectare of crop in twenty-four hours.

Control:

Our crop was not economically affected by this pest, but we sprayed a chemical called fastac to kill them in and around the plot area.We also had a barrier crop around all the plots so they attack this crop first before attacking the crop in the trial plots. Nature also provided us with a control method,the Stork birds.The farm was full of these birds, catching the locusts for their food.During the early stages growth ,these locusts do not fly and this made it easy for the Stork birds to catch them.

***Red spider mite;** This a notorious insect during warm to hot temperatures,especially between the months of December and April ,as indicated in the Daily Temperature Record attached. They damage the plants by piercing and sucking through the tissue of the plant.

Control:

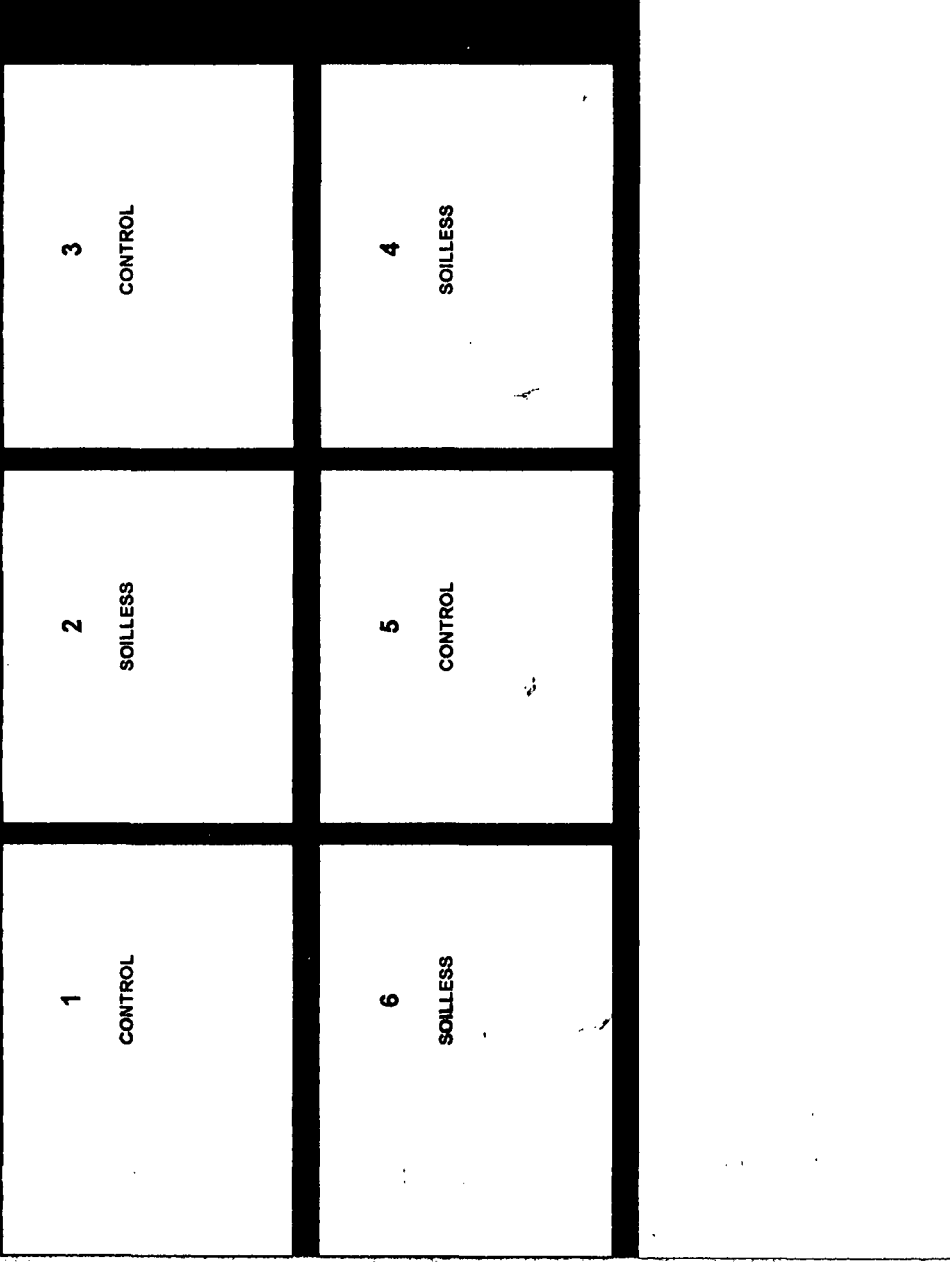
Sprayed with agrimec and hunters.

*Other pests that were noticed include aphids, thrips and bollworms, but these pests were kept under control by weekly spraying programmes.The **american leafminer** is one pest which no control has been found yet. The female lays its eggs inside the leaf tissue and the eggs hatch into small yellow maggots, which damage the leaf by forming channels along the leaf as they feed.This pest is suppressed by the same chemicals used to control red spider mite i.e. agrimec and hunters.

b.Diseases Identified:

The normal diseases associated with warm, wet and humid weather i.e.alterneria, downey mildew, leaf spot, early and late blight were identified but were kept under control by weekly spraying programs.

PLOT LAY-OUT



The Treatment Area:

1. Each of the six [6] plots measure **10 meters wide by 30 meters long** and they are divided by **path-ways** which are 1.2 meters wide.

2. The **dark blue color demarcates** the plots into 1,2,3,4,5 and 6 treatment areas.

3. Plots 2,4 and 6 were treated with **1.5 tones of raw poultry manure plus 96 tones of river sand**. The same basal and top dressing was applied to all the plots.

4. The **red color on the PLOT LAY-OUT demarcates** that piece of land into 10 000 meters [one hectare]. The **light blue color** is the area which was grown to **other tomatoes** which are not part of the trials. The **bold red color** to the left of plots 1 and 6, is the end of the farm and there is a **boundary fence**.

*Please note that the PLOT LAY-OUT diagram was not drawn to scale.

5. The **red color**, apart from demarcating the land into one[1] hectare plots, also **shows the farm roads**. This block and other blocks on the farm, have names. This block in question is called 18B and it is surrounded by blocks 18A, 12B and EXTENSION 2.

4. AFTER CULTIVATION

4.1. a. Yield;

MARCH

Grades	Plot No: 1[control]			Plot No: 2[soilless]			Plot No: 3[control]		
	first [kgs]	2nd. [kgs]	3rd. [kgs]	first [kgs]	2nd. [kgs]	3rd. [kgs]	first [kgs]	2nd. [kgs]	3rd. [kgs]
Date 6	13.450	11.300	10.050	3.250	3.750	2.350	5.800	4.750	5.450
11	97.800	13.050	2.900	4.050	8.950	4.150	9.600	15.600	3.600
13	13.200	12.150	4.050	4.900	7.350	0.000	8.350	9.300	2.750
15	18.150	15.350	2.900	6.300	9.000	3.400	9.430	8.100	0.000
18	23.400	21.200	0.000	4.000	8.400	0.000	70.800	71.350	28.500
21	22.700	11.350	0.000	6.450	12.000	0.000	59.300	13.850	2.100
26	84.480	101.400	5.200	18.400	45.900	2.700	95.900	107.650	7.300
27	20.450	47.650	0.000	10.250	8.650	0.000	36.700	33.400	3.000
30	31.000	38.600	39.500	5.600	18.850	3.500	37.450	46.950	4.250
Totals	324.630	272.050	64.600	63.200	122.850	16.100	333.330	310.950	56.950
			661.280			202.150			701.230

APRIL

Grades	first [kgs]	2nd. [kgs]	3rd. [kgs]	first [kgs]	2nd. [kgs]	3rd. [kgs]	first [kgs]	2nd. [kgs]	3rd. [kgs]
Date 3	23.150	38.700	0.000	9.400	13.850	0.000	33.200	60.200	4.200
4	18.900	13.950	0.000	3.050	6.450	0.000	29.900	18.500	0.000
5	11.000	37.200	0.000	2.950	7.800	0.000	9.500	40.800	0.000
8	15.300	58.050	4.700	10.450	20.150	2.750	20.150	92.300	4.800
10	24.050	71.850	3.400	4.950	20.400	2.450	19.400	62.750	3.450
13	16.600	87.250	3.400	14.850	29.950	3.400	56.400	86.250	6.650
15	52.250	81.600	3.700	50.200	5.000	4.950	59.850	62.350	6.900
18	114.300	51.500	4.200	53.950	65.750	4.450	65.750	55.100	5.000
20	14.900	32.300	2.600	19.250	74.750	3.100	38.850	35.300	3.400
22	36.800	45.200	3.550	21.300	28.750	6.650	44.450	41.300	4.500
26	43.050	24.800	0.000	35.650	37.000	5.000	63.400	57.850	3.200
Totals	370.300	542.400	25.550	226.000	309.850	32.750	440.850	612.700	42.100
			938.250			568.600			1095.650

MAY

Grades	first [kgs]	2nd. [kgs]	3rd. [kgs]	first [kgs]	2nd. [kgs]	3rd. [kgs]	first [kgs]	2nd. [kgs]	3rd. [kgs]
Date 2	58.350	12.350	4.800	24.900	102.430	3.250	40.200	86.450	6.050
13	14.300	76.350	3.800	65.450	101.700	7.750	13.150	19.050	4.300
Totals	72.650	88.700	8.600	90.350	204.130	11.000	53.350	105.500	10.350
			169.950			305.480			169.200

JUNE

Grades	first [kgs]	2nd. [kgs]	3rd. [kgs]	first [kgs]	2nd. [kgs]	3rd. [kgs]	first [kgs]	2nd. [kgs]	3rd. [kgs]
Date 4	15.200	64.340	4.800	74.500	20.240	8.750	12.250	21.040	3.400
20	0.000	0.000	0.000	0.000	0.000	0.000	0.000	4.800	0.000
21	0.000	1.440	0.000	0.000	4.800	0.000	0.000	1.440	0.000
22	0.000	4.800	0.000	0.000	7.200	0.000	0.000	4.800	0.000
24	0.000	2.400	4.800	0.000	2.400	9.600	0.000	2.400	7.200
Totals	15.200	72.980	9.600	74.500	34.640	18.350	12.250	34.480	10.600
			97.780			127.490			57.330

JULY

Grades	first [kgs]	2nd. [kgs]	3rd. [kgs]	first [kgs]	2nd. [kgs]	3rd. [kgs]	first [kgs]	2nd. [kgs]	3rd. [kgs]
Date 3	0.000	2.400	1.200	0.000	7.200	0.000	0.000	8.400	2.400
Totals	0.000	2.400	1.200	0.000	7.200	0.000	0.000	8.400	2.400
			3.600			7.200			10.800

MARCH

Grades	Plot No: 6[soilless]			Plot No: 5[control]			Plot No: 4[soilless]		
	first [kgs]	2nd. [kgs]	3rd. [kgs]	first [kgs]	2nd. [kgs]	3rd. [kgs]	first [kgs]	2nd. [kgs]	3rd. [kgs]
6	4.050	3.850	4.150	13.000	21.300	15.300	4.400	7.400	2.350
11	3.650	4.750	0.000	15.550	23.700	3.650	17.600	12.200	2.700
13	3.600	5.750	2.550	12.800	5.750	2.650	4.350	7.500	2.300
15	0.000	6.300	3.250	15.250	13.400	4.700	8.950	18.450	5.000
18	2.300	6.000	0.000	2.850	4.800	1.850	11.150	13.500	1.450
21	2.000	3.650	0.000	49.300	12.700	1.600	8.000	15.550	0.000
26	5.250	16.400	0.000	10.050	45.050	0.300	63.500	94.200	0.500
27	3.950	5.400	1.100	52.400	48.950	0.000	12.500	20.050	0.000
30	3.900	7.400	3.500	24.950	42.950	0.000	6.300	12.090	0.000
Totals	28.700	59.500	14.550	196.150	218.600	29.850	136.750	198.940	14.300
		102.750			444.600			349.990	

APRIL

Grades	first [kgs]	2nd. [kgs]	3rd. [kgs]	first [kgs]	2nd. [kgs]	3rd. [kgs]	first [kgs]	2nd. [kgs]	3rd. [kgs]
3	9.900	23.350	0.000	21.600	55.350	0.000	10.600	15.400	3.550
4	3.500	8.850	0.000	16.700	18.650	2.500	4.350	11.200	0.000
5	4.700	7.050	0.000	24.700	31.400	3.000	8.050	12.400	0.000
8	5.550	7.700	0.000	34.450	63.850	5.700	11.800	1965.000	2.950
10	4.550	12.000	0.000	22.600	62.600	3.950	6.050	13.650	2.200
13	11.950	14.300	3.950	37.850	71.400	8.450	11.950	28.700	4.600
15	35.650	26.200	4.250	67.000	81.050	13.350	21.100	16.050	4.750
18	22.900	13.900	2.100	31.800	38.000	0.000	34.800	74.350	8.850
20	13.700	10.650	0.000	26.450	17.450	5.400	19.350	27.000	4.650
22	12.350	16.700	2.800	34.450	23.200	4.400	18.950	26.800	2.800
26	44.250	40.700	2.750	48.400	47.600	4.400	45.750	49.400	0.000
Totals	169.000	181.400	15.850	366.000	510.550	51.150	192.750	2239.950	34.350
		366.250			927.700			2467.050	

MAY

2	24.900	101.710	2.950	11.700	77.900	0.050	22.950	61.200	0.000
13	31.100	90.900	4.900	15.100	44.550	1.800	13.300	68.700	3.700
Totals	56.000	192.610	7.850	26.800	122.450	1.850	36.250	129.900	3.700
		256.460			151.100			169.850	

JUNE

4	22.000	50.400	5.800	14.200	34.550	1.700	12.200	47.500	4.000
20	32.000	9.300	3.500	12.420	47.100	1.500	17.320	72.900	3.000
21	0.000	0.000	0.000	0.000	0.000	0.000	0.000	4.800	0.000
24	0.000	2.400	12.000	0.000	4.800	12.000	0.000	14.400	2.400
Totals	54.000	62.100	21.300	26.620	86.450	15.200	29.520	139.600	9.400
		137.400			128.270			178.520	

JULY

3	0.000	6.000	1.200	0.000	7.200	1.200	0.000	9.600	0.600
Totals	0.000	6.000	1.200	0.000	7.200	1.200	0.000	9.600	0.600
		7.200			8.400			10.200	

TOTAL MONTHLY YIELD IN KGS.

	SOILLESS			CONTROL			MONTH TOTALS
	first	second	reject	first	second	reject	
March	228.650	380.290	44.950	854.110	854.180	151.400	2513.580
April	650.950	2731.200	82.950	1177.150	1665.650	118.800	6426.700
May	452.100	526.640	22.550	152.800	316.650	20.800	1491.540
June	158.020	236.340	49.050	54.070	193.910	35.400	726.790
July	0.000	22.800	13.600	0.000	18.000	4.800	59.200
TOTAL YIELD PER GRADE AND PER TREATMENT	1426.520	3897.270	213.100	2238.130	3048.39	331.200	11217.81
		5536.890			5680.920		

TOTAL YIELD FOR ALL THE TREATMENTS

11217.81 kilograms [11.218 tones]

THE YIELD:

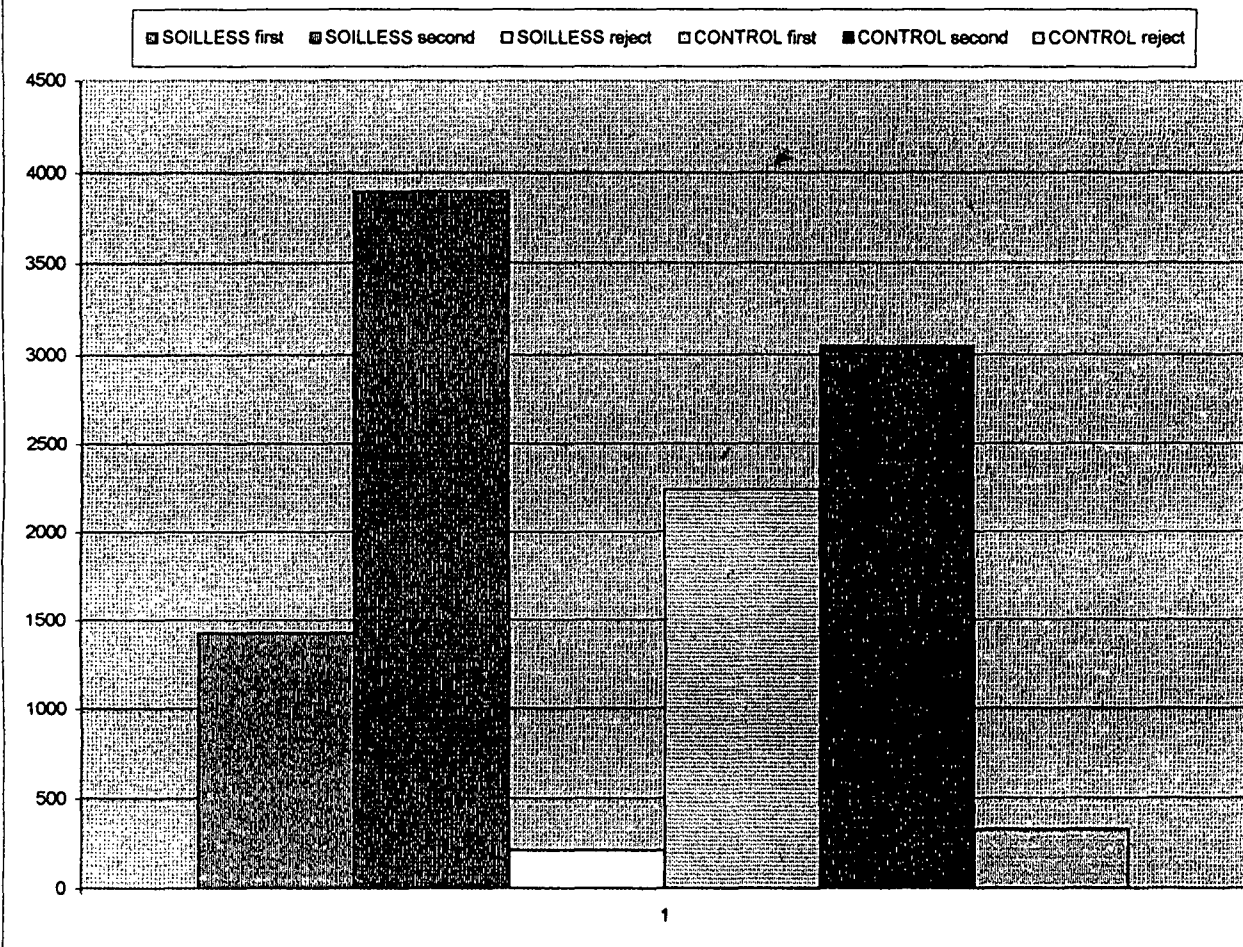
The following data can be extracted from the yield tables;

- 1 That after planting on 21 December 2001, the first crop was harvested approximately after eighty (80) days of transplanting, that is on 6 March 2002 and the last picking was on the 3rd. July 2002.
The crop was harvested in 28 days [9 days in March, 11 in April, 2 in May, 5 in June and 1 day in July].
- 2 That all plots were harvested separately, sorted into first, second and reject or third grades, weighed and recorded accordingly on each day of harvesting.
- 3 Although the two [2] treatments have yielded almost the same, that is, SOILLESS 5536.890 kilograms and CONTROL 5680.92 kilograms, and also produced about the same saleable tomatoes [first and second grades only], the CONTROL treatment produced 7.2 % more first grades than the SOILLESS.
- 4 After starting harvesting on the 6th. March, the crop went into peak of harvesting [6426.700] kilograms, in April and harvests dropped drastically thereafter to 1491.540, 726.790 and 59.200 kilograms respectively- this is quite unusual. The main cause was because of the bad frost we received on the 8th. May, as indicated by the red color on 9 and 22 on the DAILY TEMPERATURE RECORD table.
- 5 Yield comparison as a percentage of the total yield [11217.810 kilograms] ;

SOILLESS			CONTROL		
first	second	reject	first	second	reject
1426.52	3897.27	213.1	2238.13	3048.39	331.2
12.72%	34.74%	1.90%	19.95%	27.17%	2.95%
		49.35%			50.07%

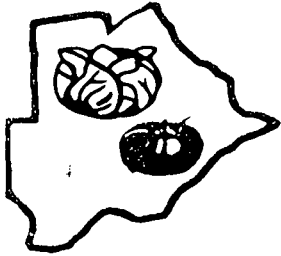
As stated earlier on, the CONTROL treatment performed better yield wise than the SOILLESS treatment as high lighted by the above comparison by percentage.

YIELD COMPARISON BY GRADES



6 Yield Per Plant;

	Soilless	Control
Total number of plants	900	900
Total Yield [kilogramms]	5536.89	5680.92
Yield Per Plant	6.15	6.31



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UNIDO INCOME STATEMENT PERIOD JULY 2001 - JULY 2002

	EXPENSES	INCOME	
INCOME PAID EX UNIDO		37,757.06	
ADMINISTRATION EXPENSES	750.00		
CHEMICALS	2,736.89		
ELECTRICITY & WATER	1,798.15		
FERTILIZER	2,615.04		
FUEL & TRANSPORT	426.78		
IRRIGATION (DRIP TAPE)	3,670.28		
LAND PREPARATION	4,227.50		
MANAGEMENT	8,950.00		
PACKAGING	3,184.85		
PROTECTIVE CLOTHING	416.00		
SEEDLINGS	1,699.53		
WAGES	4,709.65		
	35,184.67	37,757.06	2,572.39