

SOUTH AFRICAN SUGAR INDUSTRY

AGRONOMISTS' ASSOCIATION

IRRIGATION TRIAL

Catalogue No: 117  
This crop: Plant  
Site: Ottawa Section, N.E.L.  
Altitude: 200'  
Soil Series: Windermere clay  
Design: Random block  
Variety: N:Co.376  
Fertilizer:  
 Amm. Nitrate 31% N 400 lbs/ac  
 Supers 8.3% P 600 lbs/ac  
 M. Potash 50% K 300 lbs/ac  
 for all plots.  
Water Regime: Irrigated trial

Soil Analysis: (Beater)

pH	ppm			
	P	K	Ca	Mg
8.0	23	47	7469	331

Age: 14 months (8/63 - 11/64)  
Rainfall this crop: 35.76"

Object:

To determine the optimum water duty on a Windermere clay soil.

Treatments:

1. Water Duty of 1 cusec per 125 acres
2. Water Duty of 1 cusec per 250 acres
3. Control, no irrigation.

Results:

Overhead Treatments	% Sucrose	T.C.A.	T.C. A.M.	T.S.A.	lbs. S.A.M.	Purity	Rank		Irrig.	Rain.
							Cane	Suc		
1 Cusec per 125 acres	14.34	48.6	3.472	6.969	996	90.4	1	1	26"	35.7"
1 Cusec per 250 acres	14.41	47.3	3.379	6.816	974	90.4	2	2	17"	35.7"
Control	14.06	26.2	1.871	3.683	526	90.2	3	3	-	35.7"

S.E. =  $\pm 6.14$

C.V. = 15.2%

Treatment difference highly significant.

L.S.D. between treatments = 2.776 T.P.A. @ 5%  
 4.604 T.P.A. @ 1%

Conclusions:

1. A substantial increase from irrigation is recorded, averaging 82.8% over dry land.
2. The difference between the two water duties is insignificant and less than expected.

Accumulative E.T. over growth period of 14 months = 55.18" water utilization.

Treatments	Irrig & Rain	T.C/1"	1"/T.C.
1 cusec/125A.	61.76'	0.79	1.27
1 Cusec/250A.	52.76"	0.90	1.11
Control	35.76"	0.74	1.35

29th November, 1966.

IRRIGATION EXPERIMENT : OTTAWA

Catalogue No: 117  
This crop: 1st Ratoon  
Site: Ottawa section  
           Hulett's (Mount Edgecombe)  
Altitude: 400 ft.  
Soil series: Windermere clay  
Design: 5 x 3 Randomised Blocks  
Variety: N:Co.376  
Fertilizer, lb./ac.: N    P    K  
                           139 34 203  
Rainfall this crop: 30.48 in.

Soil Analysis

			p.p.m.			
pH	O.M.%	Clay %	P	K	Ca	Mg
<u>Age:</u> 11½ months (6/11/64 - 26/10/65)						

Object: To determine the optimum water duty and to determine the response to different water treatments.

Treatments: Five water treatments were applied as follows :-

Period up to 31/3/65 (Estimated T.A.M. 2.54")

- A. Irrigate at a deficit of 1" in 2 ft. estimated A.M. of 1.54"
- B. " " " " " 2" " " " " " 0.54"
- C. " " " " " 3" " " " " " - 0.46"
- D. " " " " " 4" " " " " " - 1.46"
- E. No irrigation.

The deficits were estimated from Class A Pan evaporation. The following amounts of water were applied; A 11", B 9", C 8", D 7".

From 1/4/65 to 26/10/65 (Field Capacity 10.5" in 2 ft.)

Following installation of access tubes and calibration of the neutron probe, treatments were controlled as follows :-

- A. Irrigate at 1.5" deficit in 2 ft. i.e. at Total Moisture of 9"
- B. " " 2.25" " " " " " " " 8.25"
- C. " " 3.0" " " " " " " " 7.5"
- D. " " 3.75" " " " " " " " 6.75"
- E. No irrigation.

Over this period the following amounts of water were applied: A 18", B 9", C 9", D 4", to give a total over the crop of A 29", B 18", C 17", D 11".

All treatments including E were given 2" irrigation on 22/12/64; this was regarded as rainfall.

Methods and measurements:

Soil moisture was measured weekly to a depth of 6 ft. by 6" intervals using the neutron probe. One access tube was installed per plot. Surface soil moisture content was determined gravimetrically.

Height measurements were carried out at weekly intervals on ten stalks in each plot. Ground cover measurements were carried out using a ground cover quadrat until the cover averaged 85%. Stalk counts were taken on one complete row per plot. Irrigation was applied by means of perforated pipes between the cane rows. The spray from these pipes was

adjusted individually by means of diaphragm valves. The quantity of water applied was measured with a flow meter.

A net plot of 4 rows x 30' was harvested, and all stalks were topped at the base of the 6th sheath to provide a standard basis for measuring stalk length. In addition to the usual weight and sucrose determinations, the following crop characteristics were measured on a 10% sample: stalk length, stalk number, stalk diameter at three points and the distance from the 6th node (point of severance of the stalk) to the uppermost visible collar.

Results : Harvest Data.

Treatment	A	B	C	D	E	C.V.	L.s.d.	
							5%	1%
Deficit (in.)	1.5	2.25	3.00	3.75	-	-	-	-
Irrigation applied (in.)	29	18	17	11	-	-	-	-
Yield Tons cane/acre	49.3	41.8	41.7	36.8	14.5	9.0	6.2	9.1
Sucrose % Cane	13.4	13.2	13.3	12.9	11.7	4.3	1.1	1.5
Yield tons sucrose/acre	6.58	5.51	5.51	4.75	1.71	5.5	0.50	0.73
Number of stalks/acre x 10 <sup>-3</sup>	56.5	55.7	57.3	57.6	66.3	5.1	5.6	8.1
Mean stalk weight (lb.)	1.74	1.50	1.45	1.28	0.44	7.4	0.18	0.26
Mean stalk diameter (cm.)	2.60	2.61	2.54	2.60	2.33	1.1	0.09	0.13
Length to Uppermost Collar (in.)	16.6	16.1	16.0	15.5	15.0	4.4	1.3	1.9
Final Height (in.)	73.4	61.5	61.6	56.1	31.2	-	-	-
Mean stalk length (in.)	59.5	50.4	50.8	44.6	20.3	2.8	2.4	3.5
Fibre % Cane	11.3	11.3	11.6	11.7	11.1	6.6	NS	NS
Starch in juice mg/l	320	293	404	383	436	7.3	50	73
Cane yield response	34.8	27.3	27.2	22.3	-	-	-	-
Tons cane/inch water applied	1.20	1.52	1.60	2.03	-	-	-	-
Sucrose yield response	4.87	3.80	3.80	3.04	-	-	-	-
Tons sucrose/inch water applied	0.168	0.211	0.224	0.276	-	-	-	-
Tons cane/inch total water	0.83	0.86	0.88	0.89	0.48	-	-	-
Total sucrose/inch total water	0.111	0.114	0.116	0.114	0.056	-	-	-
Tons cane/foot stalk	9.94	10.02	9.86	9.89	8.58	-	-	-
Tons cane/acre/month	4.29	3.63	3.63	3.20	1.26	-	-	-

There was a significant linear increase in yield per inch of water applied, when the control treatment was omitted. This amounted to 0.68 tons cane and 0.100 tons sucrose/acre. The control treatment was omitted from the regression because of its very low yield, caused by the exceptionally severe drought in late summer. Sucrose per cent cane was significantly raised by irrigation, consequently the treatment response in terms of sucrose yield was relatively greater than that measured in cane yield. Treatment D gave the largest response per inch of water applied : 2.03 tons cane and 0.276 tons sucrose. There was no significant effect of irrigation on fibre % cane, but a trend existed towards higher fibre content with irrigation. There was a significant reduction in the starch content of the juice with increasing irrigation.

Mean stalk length and stalk weight both showed significant linear increases with increasing water treatments, omitting the control treatment (which caused a marked curvilinearity). It was surprising that stalk population at harvest was significantly higher in the control plots than in all irrigated treatments. Because of the far poorer canopy in the control plots, it is probable that smaller competition for light allowed a higher population to develop. The mean stalk diameter was significantly higher in the irrigated treatments than in the control treatment, and this was apparent for diameters measured at the top, centre and bottom of the stalk. The length of stalk from 6th node to the uppermost visible collar showed a linear increase with irrigation treatments.

Crop Measurements:

Mean weekly height increments (in inches) for the treatments were:

Month	Rainfall	A	B	C	D	E
Dec. '64	5.53	1.19	1.16	1.08	1.05	1.14
Jan. '65	2.54	2.72	2.29	2.33	2.40	2.10
Feb.	1.29	2.56	2.56	2.16	1.60	0.96
Mar.	0.67	2.88	1.77	2.24	1.94	0.15
Apr.	0.75	2.52	1.85	1.97	1.52	0.16
May	3.24	1.01	0.78	0.68	0.40	0.04
June	4.49	0.41	0.51	0.46	0.55	0.18
July	1.32	0.78	0.69	0.72	0.80	0.55
Aug.	2.75	1.07	1.04	0.97	0.86	0.55
Sep.	2.67	1.44	1.22	1.31	1.50	1.24
Oct.	2.95	0.54	0.60	0.51	0.61	0.54

It is of interest to follow the recovery of the cane in treatment E after the drought broke on May 31st, in comparison with treatment D which was not irrigated after May. During May the growth on plot E was 10% that of D, in June 33%, in July 6%, in August 64%, in September 83% and in October 89%. Thus it took three months before the growth rate was again reasonably comparable with that of the irrigated cane. The height increments of the cane in the irrigated treatments showed the expected seasonal trends, except for October when a marked reduction in height increment was associated with drying off, which was commenced six weeks before harvest.

The development of ground cover during the crop is shown below:

Treatment	% Ground Cover				
	A	B	C	D	E
December	25	20	20	21	19
January	44	40	42	39	39
February	65	61	57	60	56
March	91	85	82	78	68
April	100	100	100	100	77
May	100	100	100	100	80

Stalk counts showed the usual peak at four months in March, with very high counts of 170,000 stalks/acre being recorded. However, the stalk counts were made in the outside lines of the plots, which probably sustained higher populations than the inner rows.

Water Duty:

The determination of the optimum water duty has been discussed in a separate report.

1st December, 1965.

SOUTH AFRICAN SUGAR INDUSTRY

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WATER DUTY EXPERIMENT

<p>Catalogue No: 117                  Code: I 8/64                  This crop: 2nd Ratoon                  Site: Ottawa Section, Mt. Edgecombe                  Altitude: 400'                  Soil series: Windermere clay                  Design: 5'x 3 Randomized blocks                  Variety: N:Co.376                  Fertilizer, lb/ac.      N      P      K                                                   138    25    150</p>	<p>Soil Analysis: No samples taken                  Age: 15 months (10/65 - 1/67)                  Rainfall: 37.07 inches                  Irrigation: See results</p>
<p>Water regime: See treatments</p>	

Object: To compare four irrigation treatments with a control.

Treatments:

A: 5 day cycle )	
B: 11 day cycle )	
C: 17 day cycle )	1" per application
D: 23 day cycle )	
E: Dryland )	

Plots treated as mid-points of commercial irrigation cycles, based on predicted daily  $E_t$  and actual rainfall ( T.A.M. = 2.50")

Results:

Treatment	A	B	C	D	E	C.V.%	L.S.D.	
							.05	.01
Irrigation applied, in.	40	28	19	12	0	-	-	-
Yield, t.c.a.	67.0	58.6	48.2	47.0	24.9	6.5	6.0	8.7
Sucrose % cane	12.2	13.6	13.2	12.8	12.5	3.8	0.91	1.33
Yield, t.s.a.	8.19	7.96	6.34	6.00	3.12	10.2	1.21	1.76
No. of stalks/ac x 10 <sup>-3</sup>	55.4	55.0	56.7	57.8	51.4	2.7	2.81	4.09
Mean stalk wt., lb.	2.41	2.13	1.70	1.63	0.97	7.5	0.25	0.36
Mean stalk diam., mm.	23.5	23.5	23.9	23.8	22.9	2.4	1.08	1.57
Mean stalk length, ft.	6.77	5.83	5.33	4.79	3.51	5.8	0.57	0.84
Total effective water, in.	59.6	55.5	48.9	43.1	31.1	-	-	-
Rainfall efficiency	52.9	74.2	80.7	84.0	84.0	-	-	-
Tons cane/in. eff. water	1.12	1.06	0.99	1.09	0.80	-	-	-

Comments: Highly significant responses to irrigation were to be expected in a very dry year. Irrigation tended to produce more and longer stalks, but stalk diameters were relatively unaffected by treatment. The yield of cane per inch of effective water tended to remain constant for all water treatments, but under dryland conditions the value of this quantity was very low.

SOUTH AFRICAN SUGAR INDUSTRY.

AGRONOMISTS' ASSOCIATION.

Water Duty Experiment.

<u>Catalogue No.</u> :	117	<u>Soil analysis</u> :	No sample taken
<u>Code</u> :	I8/64	<u>Age</u> :	16 months
<u>This crop</u> :	3rd Ratoon		(1/67 - 5/68)
<u>Site</u> :	Ottawa	<u>Rainfall</u> :	47.45 in
<u>Altitude</u> :	400'	<u>Irrigation</u> :	See results.
<u>Soil series</u> :	Windermere clay		
<u>Design</u> :	5 x 3 Random block		
<u>Variety</u> :	NCo 376		
<u>Fertilizer,</u> lb/ac	N      P      K 138    25    150		
<u>Water regime</u> :	See treatments		

Object: To compare four irrigation treatments with a dryland control.

Treatments:

A : 5 - day cycle	)	
B : 11 - day cycle	)	
C : 17 - day cycle	)	1" per application
D : 23 - day cycle	)	
E : Dryland	)	

Plots treated as mid-points of commercial irrigation cycles, based on predicted Et and actual rainfall (T.A.M. = 2.50in.)

Results:

Treatment	A	B	C	D	E	CV%	L.S.D.	
							.05	.01
Irrigation applied, in.	45	29	18	13	-	-	-	-
Yield, t.c.a.	81.8	74.6	73.7	66.2	34.4	8.1	10.1	14.7
Sucrose % cane	12.7	13.7	13.8	13.7	13.2	5.4	1.35	1.97
Yield, t.s.a.	10.40	10.25	10.14	9.10	4.57	7.7	1.28	1.87
No. of stalks/ac x 10 <sup>-3</sup>	65.1	57.1	64.3	62.9	49.8	6.7	7.55	10.98
Mean stalk wt. lb.	2.52	2.62	2.29	2.10	1.38	6.5	0.26	0.39
Mean stalk length. ft.	7.5	7.2	7.0	6.7	5.2	-	-	-
Total effective water, in.	70.7	62.8	53.5	49.4	36.9	-	-	-
Rainfall eff., %	54.2	71.2	74.8	76.6	77.8	-	-	-
Tons cane/in. effect. water	1.16	1.19	1.38	1.34	0.93	-	-	-
Tons cane/in. irrigation	1.05	1.39	2.18	2.45	-	-	-	-
Tons cane/in. total water	0.88	0.98	1.13	1.10	0.72	-	-	-

Comments:

The much better rainfall on this third ratoon crop has resulted in a greater dryland yield than was obtained in the second ratoon crop. The responses to irrigation nevertheless remain highly significant. On this soil irrigation has consistently resulted in greater stalk population than those obtained in dryland plots. Yield response is thus due to a greater number of longer, heavier stalks.

Catalogue No: 117

The total productivity for this crop from a farm of 442 acres receiving 1 cusec of water to be used at the different water duties, compared with dryland production, is as follows:-

Treatment	Water duty ac/cusec	Irr. Land		Rainfed Land		Total product tons	Total days irr.	% avail time
		Area ac	t.c.a	Area ac	t.c.a.			
A	96	96	82.0	346	34.4	19,774	225	46
B	211	211	75.2	231	34.4	23,814	319	65
C	323	323	70.6	116	34.4	27,006	306	63
D	442	442	68.5	-	-	30,277	299	61
E	-	-	-	442	34.4	15,205	-	-

The irrigated cane yields in this table are those estimated from the linear regression equation relating yield and inches of irrigation water applied.



SOUTH AFRICAN SUGAR INDUSTRY

AGRONOMISTS' ASSOCIATION

WATER DUTY EXPERIMENT

Catalogue No: 117	Soil analysis : No sample taken
Code: I 8/64	
This crop: R4	Age: 12.8 months
Site: Ottawa	21/5/68 - 11/6/69
Altitude: 400'	
Soil series: Windemere clay	Rainfall: 33.48 inches
Design: 5 x 3 Random blocks	
Variety: N:Co.376	Irrigation: See results
Fertilizer: N P K	
lb/ac 100 33 100	
Water regime: See treatments	

Object: To compare four irrigation treatments with a dryland control

Treatments:

A: 5 - day cycle )	1" per application
B: 11 - day cycle )	
C: 17 - day cycle )	
D: 23 - day cycle )	
E: Dryland	

Plots treated as mid-points of commercial irrigation cycles, based on predicted Et and actual rainfall (T.A.M. = 2.50 inches).

Results:

TREATMENTS	A	B	C	D	E	SE	CV%	L.S.D.	
								0.05	0.01
Irrigation applied in	27.00	15.00	10.00	7.00	-				
Yield, T.C.A.	45.5	37.3	34.8	32.8	27.2	2.10	10.2	6.8	9.9
Suerose % cane	11.0	10.1	9.6	9.1	8.8	0.37	6.6	1.2	1.8
Yield T.S.A.	4.96	3.72	3.35	3.00	2.38	0.18	9.0	0.59	0.86
No. of stalks/ae x 10 <sup>-3</sup>	51.3	52.8	52.3	53.1	49.8				
Mean stalk wt. lb.	1.77	1.41	1.33	1.24	1.10				
Mean stalk length ft.	5.51	4.82	4.34	4.05	3.42				
Total effective water in	45.93	40.89	36.64	34.60	28.55				
Rainfall eff. %	56.5	77.3	79.6	82.4	85.3				
Tons cane/in effect. water	0.99	0.91	0.95	0.95	0.95				
Tons cane/in irrigation	0.68	0.67	0.76	0.80	-				
Tons cane/in total water	0.75	0.77	0.80	0.81	0.81				

Comments: i) T.C.A., T.S.A. & S % C respond linearly to increasing amount of irrigation applied, (no significant deviations from linearity; dryland treatment included)

ii) Average response for extra inch of irrigation applied

T.C.A.	0.66	±	0.104
T.S.A.	0.095	±	0.009
S.% C.	0.084	±	0.018

iii) Regression line (from A,B,C,D treatments only)

$$\hat{T.C.A.} = 37.58 + 0.631 (\text{Irrigation}'' - 14.75)$$

$$= 28.27 + 0.631 \text{Irrigation}''$$

Irrigation''	$\hat{T.C.A.}$	T.C.A. - $\hat{T.C.A.}$
27	45.3	0.2
15	37.7	-0.4
10	34.6	0.2
7	32.7	0.1

III) The responses to irrigation are much smaller than for previous crops. This can be partly attributed to the earlier harvesting (12.8 months) and the unfavourable cropping cycle (May-June). Tons cane produced per inch of effective water was close to the expected value of 1.00 for all treatments. Tons cane produced per inch of applied irrigation water and per inch of total water was much lower than for previous crops. The yield response was due to a slight increase in the number of stalks, but mainly to the greater length and hence weight per stalk.

IV) The total productivity for this crop from a farm of 442 acres receiving 1 cusec of water to be used at the different water duties, compared with dryland production, is as follows:

Treatment	Water duty ac/cu	Irrig. land		Rainfed land		Total productivity tons/cusec
		Area ac.	Yield T.C.A.	Area ac.	Yield T.C.A.	
A	96	96	45.3	346	27.2	13,760
B	211	211	37.7	231	27.2	14,238
C	323	323	34.6	116	27.2	14,435
D	442	442	32.7	-	-	14,453
E	-	-	-	442	27.2	12,022

The irrigated cane yields in this table were estimated from the linear regression equation relating yield and inches of irrigation water applied. The results confirm previous findings that the main response occurs between 96 and 211 acres per cusec (80% efficiency, 168 hours/week).