SOUTH AFRICAN SUGAR INDUSTRY

AGRONOMISTS' ASSOCIATION

Irrigation Trial II

Catalogue No.: 2
This crop: P, 1R, 2R. (Second Cycle)
Site: Jackson, Umhloti Valley.
Altitude: 140'
Soil: M.E. Shale, Windermere clay loam.
Design: Random block.
Variety: N.50/211.
Fertiliser:

		N1	N2	N3	P	K
Plant	Urea	225	450	675	500	250
1R	LAN	400	800	1200	500	300
2R	LAN		N		P	K
			800		500	300

Soil Analysis:

	pH	OM %	Clay %	P p.p.m.	K p.p.m.	Ca p.p.m.	Mg p.p.m.
Plant:	5.33	3.23	-	15	115	2030	1222
1R	5.28	2.95	-	23	165	1299	279
2R	5.79	5.59	44.3	66	228	1160	762

Age:

Plant	15 mths.	June 1962 - Aug. 1963.
1R	11 mths.	Aug. 1963 - July 1964.
2R	12 mths.	July 1964 - July 1965.

Treatments:

Plant - 1st Ratoon

W0 = No irrigation. Dryland.
W1 = 1" below F.C. = Irrigation 1 inch.
W2 = 2" " " = " 2 "
W3 = 3" " " = " 3 "

2nd Ratoon

W0 = No irrigation. Dryland.
W1 = 1" below F.C. = Irrigation 1 inch.
W2 = 2" " " = " 2 "
W3 = 3" " " = " 3 "
F0 = Fertiliser on cane line.
F1 = " " interrow.
S0 = No subsoiling.
S1 = Subsoiling.

Results:

Plant - 1st Ratoon

Tons Cane per Acre.

Crop	W0	W1	W2	W3	N1	N2	N3
P	23.7	39.1	36.3	26.8	30.9	32.2	31.3
1R	17.0	43.1	34.3	27.1	31.8	29.6	29.8

2nd Ratoon

Tons Cane per Acre.

Crop	W0	W1	W2	S0	S1	F0	F1
2R	5.5	31.9	27.4	21.6	21.6	21.6	21.6

Plant - 1st Ratoon

Sucrose % Cane.

Crop	W0	W1	W2	W3	N1	N2	N3
P	12.1	13.8	13.2	11.7			
1R	12.2	13.0	12.7	12.6			

2nd Ratoon

Sucrose % Cane.

Crop	W0	W1	W2	S0	S1	F0	F1
2R	10.2	13.7	12.6	12.4	11.9	12.3	12.0

Plant - 1st Ratoon

Tons Sucrose per Acre.

	Crop	W0	W1	W2	W3	
62/3	P	2.87	5.38	4.78	3.14	6.43
63/4	1R	2.07	5.61	4.36	3.40	4.64

2nd Ratoon

Tons Sucrose per Acre.

	Crop	W0	W1	W2	S0	S1	F0	F1	
64/5	2R	0.58	4.38	3.43	2.77	2.70	2.82	2.77	1,30

9th May, 1966.

SOUTH AFRICAN SUGAR INDUSTRY

AGRONOMISTS' ASSOCIATION

Irrigation Trial II.

Catalogue No.: 2.
This crop: P, 1R, 2R, 3R.
Site: Jackson, Umhloti Valley.
Altitude: 140'
Soil: M.E. Shale, Windermere.
Design: Random Block with split nitrogen plots.
Variety: N:Co.310.
Fertiliser:

	N1	N2	N3	P	K
Plant = A/N	300	600	900	1000	300
1R = A/N	300	600	900	500	300
2R = A/N	300	600	900	500	300
3R = Urea	225	450	675	500	300

Water regime: Irrigated land.

Soil analysis:

	pH.	OM %	Clay %	P p.p.m.	K p.p.m.	Ca p.p.m.	Mg. p.p.m.
Plant:	-	-	-	-	-	-	-
1R	5.69	4.81	-	51	221	-	-
2R	5.80	5.29	-	60	190	3060	-
3R	5.66	3.81	-	191	142	-	1058

Age:
Plant = 20 mths. March 1956 - Nov. 1957.
1R = 13 mths. Nov. 1957 - Dec. 1958.
2R = 18 mths. Dec. 1958 - June 1960.
3R = 18 mths. June 1960 - Dec. 1961.

Object:

Treatment: W0 = No irrigation. Dryland.
W1 = 1 inch irrigation every seven days.
W2 = 2 " " " fourteen days.
W3 = 3 " " " twenty one days.
N1 = Amm. nitrate 300 lbs/ac.
N2 = " " 600 lbs/ac.
N3 = " " 900 lbs/ac.

Results:

Tons Cane per Acre.

Crop	W0	W1	W2	W3	N1	N2	N3
P	34.9	57.1	49.4	48.6	46.3	46.0	50.2
1R	27.0	43.5	41.1	42.7	35.4	39.9	40.9
2R	21.2	56.8	50.7	47.5	39.7	45.3	47.1
3R	24.6	37.0	34.6	30.4	28.4	32.0	34.7

Plant Cane = L.S.D. (1%) 10.16 T.C.A.; (5%) 7.07 T.C.A.

Sucrose % Cane.

Crop	W0	W1	W2	W3	N1	N2	N3
P	15.5	16.3	15.9	15.9	16.2	15.8	15.6
1R	14.4	15.4	15.6	15.8	15.3	15.4	15.2
2R	14.2	14.3	14.4	14.6	14.4	14.4	14.4
3R	13.6	14.9	15.3	15.1	15.2	14.5	14.5

Catalogue No. 2.

Tons Sucrose per Acre

	Crop	W0	W1	W2	W3	N1	N2	N3	
66/7	P	5.42	9.28	7.87	7.75	7.53	7.31	7.91	11,14
67/8	1R	4.07	6.67	4.31	6.77	5.46	6.18	6.32	9.12
59/60	2R	3.01	8.13	7.29	6.93	5.71	6.54	6.77	6,70
60/61	3R	3.38	5.49	5.29	4.59	4.31	4.29	5.08	7.87

9th May, 1966.

SOUTH AFRICAN SUGAR INDUSTRY

AGRONOMISTS' ASSOCIATION

IRRIGATION TRIAL II

Catalogue No :	2
This crop:	3rd Ratoon
Site:	Jackson, Umhloti Valley
Altitude:	140'
Soil series:	Windermere clay loam
Design:	Random Block
Variety:	N50/211
Fertilizer:	Urea. D. Supers. M.ofPot. 400 100 200
Water regime:	Irrigated

Soil Analysis:

pH	OM%	Clay%
5.81	5.42	47.31

p.p.m.

P	K	Ca	Mg
92	225	1222	625

Age: 13 months. July 1965 - Aug. 1966
Rainfall: 30.88"
Irrigation: See treatment

Object: To determine optimum water duties for Windermere soils at Tongaat.

Treatments:

Dryland Control	- Wo
1" every 8 days	- Wa
1" every 11 days	- Wb
1" every 14 days	- Wc

These irrigated treatments were furthermore split for times of irrigation as follows :-

Wa1	=	1" on	27.10.65	and every	8	days	thereafter.	
Wa2	=	1" "	29.10.65	"	"	8	"	"
Wa3	=	1" "	4.11.65	"	"	8	"	"
Wb1	=	1" on	27.10.65	"	"	11	"	"
Wb2	=	1" "	30.10.65	"	"	11	"	"
Wb3	=	1" "	5.11.65	"	"	11	"	"
Wc1	=	1" on	28.10.65	"	"	14	"	"
Wc2	=	1" "	5.11.65	"	"	14	"	"
Wc3	=	1" "	8.11.65	"	"	14	"	"

AMOUNTS OF IRRIGATION

Wo	NIL
Wa1	32 inches
Wa2	32 "
Wa3	32 "
Wb1	23 "
Wb2	23 "
Wb3	23 "
Wc1	19 "
Wc2	18 "
Wc3	17 "

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RESULTS:

TREATMENTS	T.C.A.
Wo Dryland Control	14.5
Wa1 Irrigation every 8 days	28.5
Wa2 " " 8 "	32.6
Wa3 " " 8 "	32.6
Wb1 " " 11 "	29.7
Wb2 " " 11 "	24.5
Wb3 " " 11 "	25.1
Wc1 " " 14 "	24.6
Wc2 " " 14 "	24.8
Wc3 " " 14 "	23.9

SUCROSE % CANE

TREATMENT	SUCROSE%
Wo Dryland Control	14.1
Wa1 Irrigation every 8 days	14.2
Wa2 " " 8 "	13.9
Wa3 " " 8 "	14.4
Wb1 " " 11 "	14.4
Wb2 " " 11 "	14.4
Wb3 " " 11 "	14.2
Wc1 " " 14 "	14.7
Wc2 " " 14 "	14.6
Wc3 " " 14 "	14.8

TONS SUCROSE PER ACRE

6x/6.

TREATMENT	T.S.A.
Wo Dryland Control	2.05
Wa1 Irrigation every 8 days	4.05
Wa2 " " 8 "	4.54
Wa3 " " 8 "	4.68
Wb1 " " 11 "	4.26
Wb2 " " 11 "	3.54
Wb3 " " 11 "	3.59
Wc1 " " 14 "	3.61
Wc2 " " 14 "	3.61
Wc3 " " 14 "	3.53

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CROP MEASUREMENTS AT HARVEST

TREATMENT	POPULATION STALK/ AC. x 10^{-3}	STALK LENGTH (INCHES)	STALK DIAMETER (CMs) BOTTOM	MIDDLE	TOP	YIELD T.C.A.
Wo	35.1	46.3	2.55	2.48	2.57	14.5
Wa1	46.0	64.7	2.54	2.56	2.72	28.5
Wa2	43.4	67.4	2.68	2.60	2.85	32.6
Wa3	44.5	67.4	2.71	2.62	2.80	32.6
Wb1	46.3	67.3	2.60	2.53	2.66	29.7
Wb2	42.6	57.8	2.58	2.57	2.71	24.5
Wb3	41.8	62.5	2.60	2.56	2.73	25.1
Wc1	42.7	58.4	2.71	2.61	2.74	24.6
Wc2	43.7	56.7	2.74	2.63	2.78	24.8
Wc3	41.2	57.4	2.65	2.55	2.72	24.0

STATISTICAL ANALYSIS OF RESULTS

A. YIELD T.C.A.

ANALYSIS OF VARIANCE

Source	D.F.	S.S.	M.S.
Blocks	3	189.2	
Treatments	11	1957.3	177.9
Error	33	1712.5	51.9
Total	47	3859.0	

S.E. of a single yield = 7.2
C.V. = 13%
L.S.D. of treatment totals = 39.9 (5%)
= 52.5 (1%)

TREATMENT COMPARISONS

Wa2 vs Wo **
Wa2 vs Wb3 NS (almost *)
Wa2 vs Wc3 NS (" *)
Wa2 vs Wc1 NS (" *)
Wa2 vs Wc2 NS (" *)
Wa2 vs Wb2 NS (" *)

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B. SUCROSE % CANE.

ANALYSIS OF VARIANCE

Source	D.F.	S.S.	M.S.
Blocks	3	1.02	
Treatments	11	2.91	.26
Error	33	4.45	.13
Total	47	8.38	

S.E. of Single Valve = 0.1161
C.V. = 0.81%
L.S.D. of treatment totals = 2.0 (5%)
= 2.7 (1%)

TREATMENT COMPARISONS

Wc3	vs	Wa2	**	Wb2	vs	Wa2	*
Wc3	vs	Wo	**	Wb2	vs	Wal	NS
Wc3	vs	Wal	*	Wbl	vs	Wal	NS (almost *)
Wc3	vs	Wb3	NS				
Wc3	vs	Wb2	NS (almost *)				
Wc3	vs	Wbl	NS (" *)				
Wc3	vs	Wa3	*				

C. YIELD T.S.A.

ANALYSIS OF VARIANCE

Source	D.F.	S.S.	M.S.
Blocks	3	4.22747	
Treatments	11	40.23160	.3657
Error	33	36.36003	1.1018
Totals	47	80.81910	

S.E. of a single yield = 1.05
C.V. = 30%
L.S.D. of treatment totals = 5.82 (5%)
= 7.65 (1%)

TREATMENT COMPARISONS

Wa3	vs	Wo	**	Wa18	vs	Wo	**
Wa3	vs	Wb2	NS (almost *)	Wb2	vs	Wo	*
Wa3	vs	Wb3	NS (" *)	Wb3	vs	Wo	*
Wa3	vs	Wc3	NS (" *)	Wcl	vs	Wo	*
Wa2	vs	Wo	**	Wc2	vs	Wo	*
Wbl	vs	Wo	**	Wc3	vs	Wo	*

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COMMENTS:

This trial was laid down to measure the cane yield response to various water duties. Since it was felt that the time of initial application of water, i.e. the first irrigation, might influence the results by stipulating (by chance) a somewhat unrealistic pre-irrigation soil moisture deficit, it was decided to stagger the times of the first irrigation so that the whole range of possible soil moisture deficits likely to be encountered in the field would be covered by each treatment. This was achieved in the following way:-

(a) Each water duty was resolved into a set cycle length, the three being 1 inch of irrigation every 8 days, 11 days or 14 days respectively.

(b) Within each particular water duty there were three completely replicated sub-treatments which differed only as to the date of irrigation.

(c) Estimated moisture balances were kept for all treatments, in order to see the range which might develop within a particular water duty. A 1:1 factor with class A pan evaporation was adopted for this once the crop attained full canopy, prior to which time suitable fractions were employed.

Whilst the differences in cane yield within any single water duty were not expected to be great, it was nevertheless felt that the split treatments would result in a better mean result per water-duty.

During the tenure of the experiment, a measure of irrigation control, adopted from field practice at Tongaat was exercised as follows:-

Whenever rains in excess of 0.5 inches were recorded, all treatments were delayed by a similar amount of time, which was decided on general soil moisture deficits. Usually, this delay amounted to 1 day per $\frac{1}{2}$ inch of rain recorded.

The overall response to irrigation was spectacular, averaging 89% again of the dryland yield. In discussing individual water duty results, the following assumptions have been made:-

1 Cusec will irrigate 18 acres per day with 1 effective inch, resulting in 144 acres every 8 days; 198 acres every 11 days and 252 acres every 14 days for the respective treatments;

Approximately 20% of the total area under irrigation would not receive irrigation at all times for reasons such as drying-off, harvested and under a trash mulch, or fields for replanting and thus under land preparation. However, since this proportion of the total area is normally an increasing function with water duty, values at 15% for 8 days; 20% for 11 days; and 25% for 14 days have been used.

These assumptions therefore establish the water duties for each cycle time at 166 acres per cusec; 238 acres per cusec; and 315 acres per cusec respectively.

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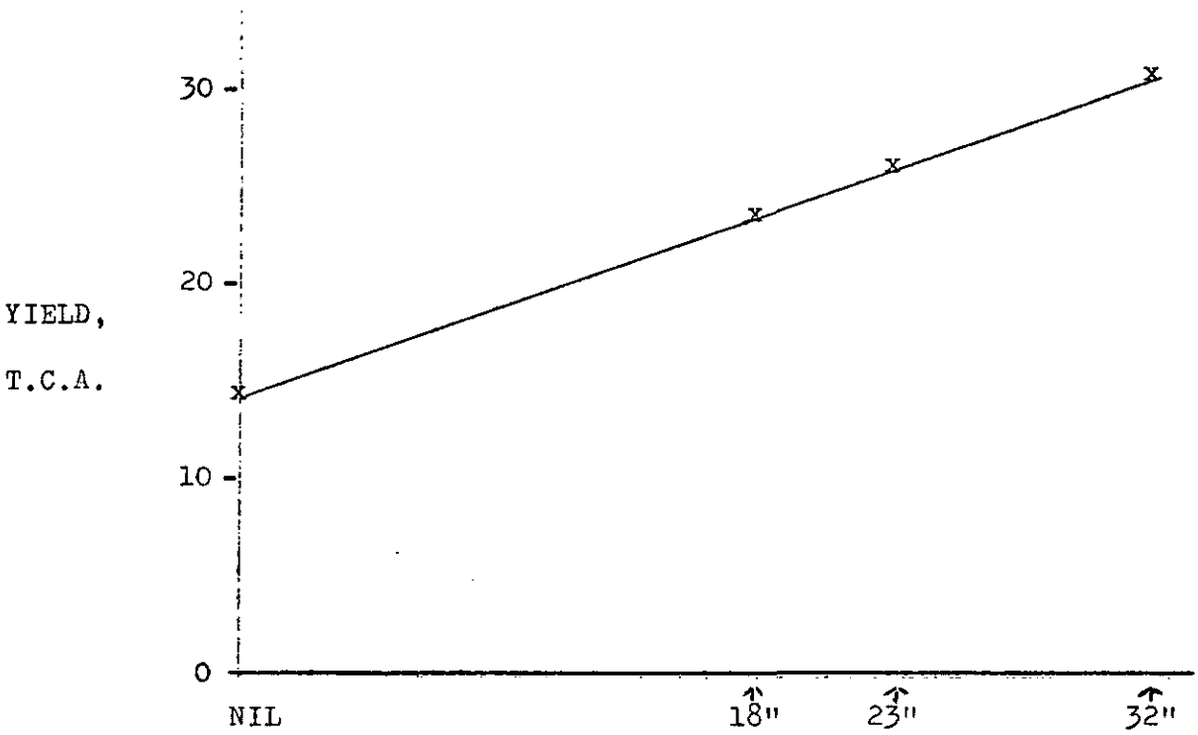
The mean yield for the 166 acres per cusec water duty was 31.2 T.C.A., being a response of 16.7 T.C.A. or 115% again of the dryland yield.

The mean yield for the 238 acres per cusec duty was 26.4 T.C.A., being a response of 11.9 T.C.A. or 82% again of the dryland yield.

The mean yield for the 316 acres per cusec duty was 24.4 T.C.A., being a response of 9.9 T.C.A. or 68% again of the dryland yield.

It is interesting to depict these yield responses in graph form:



As can be seen, the response to irrigation is almost perfectly linear.

This result is in contrast to several others obtained on the same soil series at Tongaat, where the trend has been a decreasing response to irrigation with decreasing water duties, (decreasing area to be irrigated per unit quantity of water). It is believed that this difference in trend is explicable on three accounts. Firstly, due to the very severe drought, natural rainfall was probably nearly equally effective on each water duty, instead of being decreasingly effective with decreasing water duty. Secondly, the soil profile on this experiment is extremely shallow, and thus the crop was better able to utilise more frequent irrigations, and thus put on more growth. Thirdly, it has been shown over several

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crops that soil moisture availability effects on this site were pronounced, i.e. sugarcane responded markedly to frequent but light applications of water. Thus it should be stressed that although the yield response curve was very nearly linear, these data were obtained during a most severe drought year, and it would be expected during normal years of rainfall that a curvilinear response curve be obtained.

In terms of total cane yields, the assessment of these water duties can be considered as follows:

A farmer has 315 acres of land, and 1 cusec of water available for irrigation. His choice of various water duties results in the following total cane yields from the farm:

Wa 166 acres @ 31.2 T.C.A. + 149 acres @ 14.5 T.C.A. = 7,340 tons cane.
Wb 238 " @ 26.4 " + 77 " @ 14.5 " = 7,400 " "
Wc entire area i.e. 315 acres @ 24.4 " = 7,686 " "

The farmer thus obtains his highest yield with the highest water duty, and since it can be shown from irrigation economics that the operating costs of irrigation schemes decrease rapidly with increasing water duties, then the high water duty becomes even more remunerative.

In connection with other yield data, actual yield differences within each water duty correlate well with estimated mean soil moisture deficits on the days immediately prior to irrigation.

Mean estimated soil moisture deficits which ocurred on the days immediately prior to irrigation

TREATMENT	YIELD T.C.A.	ESTIMATED SOIL MOISTURE DEFICIT INCHES		
		ENTIRE SEASON	SUMMER ONLY	WINTER ONLY
Wa1	28.5	3.13	1.98	4.85
Wa2	32.6	2.99	2.25	4.23
Wa3	32.6	2.76	1.83	3.95
Wb1	29.7	4.94	2.62	8.15
Wb2	24.5	5.45	3.35	8.72
Wb3	25.1	5.68	2.89	9.30
Wc1	24.6	6.87	3.30	11.32
Wc2	24.8	5.67	3.25	9.47
Wc3	23.9	6.56	3.74	10.58

It is quite interesting to note that the mean estimated soil moisture deficit within any particular water duty can vary by almost 0.4" in an 8 day cycle, to 0.75" in an 11 day cycle, to 1.20" in the 14 day cycle. On occasions, the individual estimated soil moisture

deficits varied by 0.63" in the 8 day cycle, to 1.20" in the 11 day cycle, to 3.06" in the 14 day cycle. These data indicate that a fairly wide range in estimated soil moisture deficits can occur by chance even within water duties, and through their influence on yield suggest that reliable water duty experiments should include some provision for gauging this effect.

The sucrose % cane results indicate a general increase in sucrose content of irrigated canes, compared to dryland cane, which has generally been the case in irrigation experiments.

The treatment means are :

Wo	=	14.1%
Wa	=	14.2%
Wb	=	14.3%
Wc	=	14.7%

These data of course substantiate the evidence in favour of higher water duties.

The crop measurements at harvest once again showed a very close correlation between stalk length and yield ($r = 0.93^{***}$) of cane per acre. Plant population was significantly increased in all irrigated plots compared to dryland figures, but there was no real pattern between water duty treatments. Irrigation has also increased stalk diameters in general, with most of the difference occurring at the top of the stalk.

J.N.S. HILL.

Maidstone.
6th October, 1966.
JNSH/JT