A(v, vii)

SOUTH AFRICAN SUGAR INDUSTRY

AGRONOMISTS' ASSOCIATION

EXPERIMENT RESULT

Code: VM 4 /88/Sw UBO 'V'
CAT.NO.: 1711

TITLE: VERTICAL MULCHING IN SOILS WITH POOR PHYSICAL PROPERTIES

1. PARTICULARS OF PROJECT

This crop	:	Plant		
Site	:	Ubombo Ranches Field Citrus		
Region	:	Northern Irrigated (Swaziland)		
Design	:	Randomised Blocks 3 replications		
Soil Set	:	'V'		
Variety	:	N14		
Fertilizer	:	N	P	K
Furrow (MAP)		100	60	
Top-dress (Urea)		90		
(KCL)				150
Total (kg/ha)		190	60	150

Soil analysis: date: 19/12/89

pH	OM%	Clay%	PDI
7.82	2.37	>40	-

ppm

P	K	Ca	Mg	Na	S	Zn
50	261	9760	1142	422	241	3.0

Dates: 20/09/88 - 24/11/89
Age : 14 months
Rainfall : 513 mm
Irrigation : 1041 mm
Total : 1554 mm

2. OBJECTIVES

2.1 To establish whether the practice of vertical mulching can improve production of sugarcane on soils which have poor physical properties.

2.2 To determine which of the most freely available materials (top-soil, sand or milo) is the more suitable to use as a vertical mulch.

2.3 To determine the importance of adequate drainage for vertical mulched crops.

3. TREATMENTS

3.1 Undrained

* Control - no mulching.

* Vertical mulching with only top - soil fed down the profile.

* Vertical mulching with 150 tons/ha of river sand fed down the profile.

* Vertical mulching with 150 tons/ha of fresh milo fed down the profile.

* Vertical mulching with 10 tons/ha of gypsum fed down the profile.

3.2 **Drained** - The vertical mulched channels were connected to sand filled slotted drains in an attempt to give a mole drain effect.

* Control- no mulching.

* Vertical mulching with only top-soil fed down the profile.

* Vertical mulching with 150 tons/ha river sand fed down the profile

* Vertical mulching with 150 tons/ha of fresh milo fed down the profile

* Vertical mulching with 10 tons/ha of gypsum fed down the profile

Notes on Treatments

* Planting ridges (as practised in Simunye) were made prior the application of the treatments.

* Sand, milo and gypsum were evenly spread by hand into the furrow on top of the ridge in the appropriate plots and lightly incorporated with a rotary hoe prior to drawing the albuster.

* The top - soil only plots were also rotavated.

* Control plots were left undisturbed.

Notes on fertilisers

* Nitrogen in the form of MAP (11 % N) was applied in the planting furrow at the rate of 30 kg N/ha and top-dressed as urea (46% N) three months later in December at the rate of 90 kg N/ha.

* Phosphorus was applied as MAP (22% P) in the planting furrow at the rate of 60 kg P/ ha.

* Potassium was top-dressed as muriate of potash (50 % K) in November two months after planting at the rate of 150 kg K/ha.

4. RESULTS

4.1 Growth Data

Table 1: Treatment effect on stalk heights (cm to TVD) and Populations (*1000/ha)

Treatments	Stalk heights (cm to TVD)				Populations (X 1000/ha)				
	5.5m	6.7m	9.7m	13m	3.7m	5.5m	6.7m	9.7m	13m
Control	114	162	219	248	172	186	122	113	122
Top soil	109	158	217	240	154	174	115	108	114
River sand	118	169	230	251	173	184	114	108	117
Milo	129	179	235	251	189	206	128	126	131
Gypsum	101	151	209	237	148	186	112	107	126

4.2 Harvest Data

Table 2: Cane Yield, Cane Quality and Sucrose Yield

Treatment	TC/ha		Suc % cane		Suc T/ha	
	D_0	D_1	D_0	D_1	D_0	D_1
Control	136	125	15.72	16.49	21.4	20.6
Top soil	124	113	16.21	16.01	20.1	18.6
River sand	135	117	15.35	16.48	20.8	19.3
Milo	146	151	15.22	16.25	22.1	24.5
Gypsum	118	119	15.30	16.69	18.1	19.9
LSD (0.05)*	16		0.94		2.4	
(0.01)**	22		1.28		3.3	
Significance	*		N.S.		*	
Mean Trial	128		15.97		20.5	
SE	9		0.55		1.4	
CV %	7		3.42		6.9	

4.3 Foliar Analysis

Table 3: Third Leaf N, P and K (% dm) Values at 3.7 Months of Age In January. Mean Values for drained and undrained plots

Treatments	N	P	K	S	Ca	Mg	Zn
Control	2.08	0.24	1.25	0.20	0.37	0.21	13.8
Top soil	2.04	0.23	1.18	0.21	0.39	0.21	13.7
River sand	1.97	0.22	1.32	0.21	0.37	0.20	13.3
Milo	2.09	0.24	1.46	0.21	0.39	0.21	15.0
Gypsum	2.02	0.23	1.23	0.21	0.40	0.21	13.7
LSD (0.05)*	0.078	0.018	0.062	0.0050	0.029	0.014	1.7
(0.01)**	0.11	0.024	0.084	0.0068	0.040	0.019	2.3
Significance	*	NS	**	*	NS	NS	NS
Mean Trial	2.04	0.23	1.29	0.21	0.38	0.21	13.9
SE	0.065	0.015	0.051	0.0042	0.024	0.012	1.4
CV %	3.2	6.2	4.0	2.0	6.3	5.5	10.1

5. COMMENTS

5.1 Cane yield

The effect of treatments on cane yield was significant (Table 2). In relation to the control, milo improved cane yields, especially where there was drainage and growth measurements indicated that this was the result of a beneficial effect on stalk populations (Table 1). All the other treatments gave yields lower than that of the control.

Yields for the control, topsoil and in particular the riversand were lower in the drained plots than in the undrained ones. There was no difference, however, where milo or gypsum had been applied.

5.2 Quality

There was a tendency for the quality to be higher where the treatments were associated with drainage but the differences were not significant (Table 2).

5.3 Sucrose Yield

The effect of treatments on sucrose yields were significant and reflected the effects on Cane Yields (Table 2). The milo treatement improved sucrose yields with and without drainage although the response was better with drainage.

All other treatments appeared to reduce sucrose yields and drainage appeared to exaggerate this effect except where gypsum was applied.

The difference in yield between drained and undrained treatments was significant in the case of milo and almost singnificant in the case of gypsum.

Both milo and gypsum contain calcium. This and the fact that in the drained plots yields were better for these treatments than for the other treatments suggest that this field may have a sodicity problem. The calcium in the milo or gypsum displaces sodium which is then eliminated from the soil solution in the plots which are connected to the drain.

5.4 Foliar analysis

Significant differences in uptake of N, K, S between treatments were noted. K was significantly ($P = 0.01$) higher in the milo treatment than in any one of the other treatments. N in the riversand treatment was significantly lower ($P = 0.01$) than the control while S in all treatments was significantly ($P = 0.01$) higher than in the control.

The leaf nutrient contents in all treatments, including the control, were above FAS threshold values. It is unlikely, therefore, that nutritional effects would have caused the yield differences observed in this trial.

6. CONCLUSION

Results of this trial have shown that the yield of sucrose of plant cane grown on a 'V' set soil could be improved by vertical mulching but only when used in combination with milo.

The best response to milo were obtained where the vertical mulching channels were connected to a service drain. It is unclear, however,whether this effect is the result of improved drainage of this heavy soil or whether it is the result of a reclamation process involving the combination of sodium displacement and its elimination by drainage.

More comprehensive physical soil analysis are required before these results can be fully explained and this trial has been continued.

PCH
6/06/1990

A (v, vii)

SOUTH AFRICAN SUGAR INDUSTRY

AGRONOMISTS' ASSOCIATION

EXPERIMENT RESULT

CODE: VM 4/88/Sw UBO 'V'

CAT. NO.: 1711

TITLE: VERTICAL MULCHING IN SOILS WITH POOR PHYSICAL PROPERTIES

1. PARTICULARS OF PROJECT

This crop	:	1st ratoon
Site	:	Ubombo Ranches Field Citrus
Region	:	Northern Irrigated (Swaziland)
Design	:	Randomised Blocks 3 replications
Soil Set	:	'V'
Variety	:	N14
Fertilizer kg/ha	:	N 265, P 40, K 60

Soil analysis: Date: 19/12/89

pH	OM%	Clay%	PDI
7.82	2.37	>40	-

ppm

P	K	Ca	Mg	Na	S	Zn
50	261	9760	1142	422	241	3.0

Dates: 24/11/89 - 10/11/90
Age : 11.5 months

Rainfall : 259 mm
Irrigation: 772 mm
Total : 1031 mm

2. OBJECTIVES

2.1 To establish whether the practice of vertical mulching can improve production of sugarcane on soils which have poor physical properties.

2.2 To determine which of the most freely available materials (top-soil, sand or milo) is the more suitable to use as a vertical mulch.

2.3 To determine the importance of adequate drainage for vertical mulched crops.

3. TREATMENTS

The treatments were applied to the plant crop as follows:

3.1 **Undrained** (D_0)

* Control - no mulching.

* Vertical mulching with top - soil fed down the profile.

* Vertical mulching with 150 tons/ha of river sand fed down the profile.

* Vertical mulching with 150 tons/ha of fresh milo fed down the profile.

* Vertical mulching with 10 tons/ha of gypsum fed down the profile.

3.2 **Drained** (D_1) - The vertical mulched channels were connected to sand filled slotted drains in an attempt to give a mole drain effect.

* Control- no mulching.

* Vertical mulching with only top-soil fed down the profile.

* Vertical mulching with 150 tons/ha river sand fed down the profile

* Vertical mulching with 150 tons/ha of fresh milo fed down the profile

* Vertical mulching with 10 tons/ha of gypsum fed down the profile

Notes on Treatments

* Planting ridges (as practised in Simunye) were made prior the application of the treatments.

* Sand, milo and gypsum were evenly spread by hand into the furrow on top of the ridge in the appropriate plots and lightly incorporated with a rotary hoe prior to drawing the albuster.

* The treatments with VM and top soil were also rotavated.

* Control plots were left undisturbed.

Notes on fertilisers

* Nitrogen in the form of Urea (46 % N) was top-dressed at the rate of 90 kg N/ha on 19/12/89. On 25/12/89 the Estate applied an additional 160 kg N/ha by error in the form of Ammonium Sulphate (21 % N).

* Phosphorous was top-dressed as Single Supers (10.5 % P) at the rate of 40 kg P/ha on 21/12/89.

* Potassium was top-dressed as KCl (50 % K) at the rate of 60 kg K ha^{-1} on 19/12/89.

4. RESULTS

4.1 Harvest Data

Table 1: Cane Yield, Cane Quality and Sucrose Yield

Treatment	TC/ha			Suc % Cane			Suc T/ha		
	D_0	D_1	Mean	D_0	D_1	Mean	D_0	D_1	Mean
Control	99	100	99.5	15.12	15.06	15.09	15.0	15.0	15.0
Top Soil	100	102	101	14.79	15.07	14.93	14.8	15.4	15.1
River Sand	110	110	110	15.03	14.85	14.94	16.6	16.3	16.4
Milo	110	115	113	14.46	15.47	14.96	16.0	17.8	16.9
Gypsum	101	100	100	14.96	14.60	14.78	15.1	14.5	14.8
Mean	104	105	105	14.87	15.01	14.94	15.5	15.8	15.65
LSD Main Effects									
Treatment (0.05)		8			0.65			0.9	
(0.01)		10			0.88			1.2	
Drainage (0.05)		5			0.41			0.7	
(0.01)		6.5			0.56			1.0	
Significance									
Treatment		**			NS			**	
Drainage		NS			NS			NS	
Interaction (Treat. x Drainage)		NS			NS			NS	
LSD Specific effects (0.05)		11			0.92			1.6	
(0.01)		15			1.25			2.2	
SE One Plot		6			0.54			0.9	
CV %		6.0			3.6			6.0	

4.2 Foliar Analysis

Table 3: Third Leaf nutrient content at 3.5 months of age in February. (Mean values for drained and undrained plots)

Treatments	N	P	K	S	Ca	Mg	Zn
Control	2.29	0.24	1.32	0.21	0.42	0.23	10.3
Top soil	2.28	0.23	1.30	0.21	0.41	0.22	13.3
River sand	2.27	0.23	1.31	0.21	0.39	0.21	11.8
Milo	2.22	0.28	1.52	0.20	0.34	0.20	11.7
Gypsum	2.29	0.23	1.37	0.21	0.40	0.20	10.7
LSD (0.05)	0.12	0.018	0.096	0.009	0.025	0.021	2.5
(0.01)	0.17	0.025	0.13	0.012	0.034	0.029	3.4
Significance	NS	**	**	NS	**	*	NS
Mean	2.27	0.24	1.36	0.21	0.39	0.21	11.6
SE	0.10	0.015	0.079	0.007	0.020	0.017	2.0
CV %	4.5	6.3	5.8	3.6	5.2	8.1	17.5

5. COMMENTS

5.1 Cane Yield

Cane yields were much poorer in this 1st ratoon than in the plant crop. Residual effects of the treatments on cane yield were apparent where vertical mulching was combined with River Sand or Milo. Responses to these treatments were statistically significant.

Cane yield in the Milo treatment tended to be improved by drainage. Drainage had no effect on cane yield in the other treatments.

5.2 Cane Quality

The sucrose content in the different treatments tended to be lower than in the control but the differences were not significant. Sucrose content was lowest in the undrained Milo treatment and drainage appeared to improve it significantly.

The effect of drainage on sucrose content was variable and non significant except in the Milo treatment where it was apparently increased. This effect was significant because sucrose content was unaccountably low in the undrained treatment.

5.3 Sucrose Yield

Sucrose yield tended to reflect the effect of the treatments on cane yield and vertical mulching with Milo and River Sand increased sucrose yields significantly.

The best treatment was VM + Milo and this resulted from a significant improvement in the drained situation.

5.4 Leaf Analysis

Levels of N were well in excess of the threshold for the time of the year, correctly reflecting the high rate of N application. The levels of the other nutrients were also well above threshold except for Zn which was deficient. It is likely that the high levels of N stimulated the uptake of other nutrients and that the Zn deficiency was induced by the high levels of P.

There were significant differences in the content of P, K, Ca and Mg between Milo and the other treatments. P and K were higher in the Milo treatment than in any other treatment. Ca and Mg were lower in the Milo treatment, probably as a result of antagonism with K.

It is unlikely that the nutritional differences between Milo and the other treatments account for the yield differences observed as the nutrients were above or under threshold in all treatments.

6. CONCLUSION

* Results of this trial showed residual effects from vertical mulching when combined with either River Sand or Milo.

* The positive effect of these treatments could not be explained by nutritional differences. The fact that the best response was obtained in presence of drains indicates that the improvement is the result of changes in physical properties affecting soil water relationships.

* This trial is being continued and is now in its 2nd ratoon.

PCH/AGK/fjs
20 May 1991

A(V, VM)

SOUTH AFRICAN SUGAR INDUSTRY

AGRONOMISTS' ASSOCIATION

EXPERIMENT RESULT

CODE: VM 4/88/Sw UBO 'V'
CAT.NO.: 1711

TITLE: VERTICAL MULCHING IN SOILS WITH POOR PHYSICAL PROPERTIES

1. PARTICULARS OF PROJECT

This crop	:	2nd ratoon
Site	:	Ubombo Ranches Field Citrus
Region	:	Northern Irrigated (Swaziland)
Design	:	Randomised Blocks 3 replications
Soil Set	:	'V'
Variety	:	N14
Fertilizer kg/ha	:	N 160, P 40, K 100

Soil analysis: Date: 13/06/91

pH	OM%	Clay%	Silt%	Sand%
7.25	2.50	65.7	15.0	18.3

ppm

P	K	Ca	Mg	(Ca+Mg)/K
115	237	9682	1106	45

CEC : 60.51 meq/100g

Dates: 10/11/90 - 11/11/91
Age : 12.0 months

Rainfall : 282 mm
Irrigation: 619 mm
Total : 901 mm

2. OBJECTIVES

2.1 To establish whether the practice of vertical mulching can improve production of sugarcane on soils which have poor physical properties.

2.2 To determine which of the most freely available materials (top-soil, sand or milo) is the more suitable to use as a vertical mulch.

2.3 To determine the importance of adequate drainage for vertical mulched crops.

3. TREATMENTS

The treatments were applied to the plant crop as follows:

3.1 Undrained (Do)

* Control - no mulching.

* Vertical mulching with top - soil fed down the profile.

* Vertical mulching with 150 tons/ha of river sand fed down the profile.

* Vertical mulching with 150 tons/ha of fresh milo fed down the profile.

* Vertical mulching with 10 tons/ha of gypsum fed down the profile.

3.2 Drained (D_1) - The vertical mulched channels were connected to sand filled slotted drains in an attempt to give a mole drain effect.

* Control - no mulching.

* Vertical mulching with only top-soil fed down the profile.

* Vertical mulching with 150 tons/ha river sand fed down the profile

* Vertical mulching with 150 tons/ha of fresh milo fed down the profile

* Vertical mulching with 10 tons/ha of gypsum fed down the profile

Notes on Treatments

* Planting ridges (as practised in Simunye) were made prior to the application of the treatments.

* Sand, milo and gypsum were evenly spread by hand into the furrow on top of the ridge in the appropriate plots and lightly incorporated with a rotary hoe prior to drawing the albuster.

* The treatments with VM and top soil were also rotavated.

* Control plots were left undisturbed.

Notes on Fertilisers

* Nitrogen as Urea (46 % N) and MAP (11 % N) at the rate of 140 kg N ha^{-1} and 20 kg N ha^{-1} respectively were banded on the cane row on 23/11/1990, 2 weeks after harvest.

* Phosphorus as MAP (22 % P) and potassium as KCl (50 % K) at the rate of 40 kg P ha^{-1} and 100 kg K ha^{-1} respectively were broadcast on 23/11/1990, 2 weeks after harvest.

4. RESULTS

4.1 Soil Analysis

Table 1: Effect of milo on soil characteristic in May during growth of the 2nd ratoon

A) Physico-chemical properties

Treatments	Clay %	OM %	CEC meq/100g soil	KDI	PDI	pH
Control						
0-15 cm	-	2.50(0.15)	60.7 (1.2)	0.64(0.048)	0.50(0.042)	7.3(0.1)
20-30 cm	-	2.40(0.21)	63.3 (1.3)	0.71(0.058)	0.33(0.048)	7.4(0.1)
40-50 cm	-	2.20(0.17)	64.3 (3.6)	0.69(0.055)	0.27(0.075)	7.4(0.1)
Milo						
0-15	65.7(1.0)	3.80(0.27)	60.3 (1.0)	0.64(0.08)	0.06(0.01)	7.3(0.1)
20-30 cm	65.6(2.5)	2.97(0.14)	64.3 (2.0)	0.65(0.02)	0.41(0.03)	7.5(0.1)
40-50 cm	66.8(0.6)	2.40(0.31)	64.0 (1.3)	0.76(0.06)	0.28(0.06)	7.7(0.1)

B) Nutrient and salinity/sodicity status

Treatments	P	K	Ca	Mg	EC MSm^{-1}	SAR
	ppm					
Control						
0-15 cm	167 (57)	348 (32)	9763 (169)	1203 (69)	87 (29)	1.83 (0.46)
20-30 cm	115 (48)	281 (16)	9920 (12)	1330 (105)	138 (31)	3.80 (1.83)
40-50 cm	76 (27)	254 (20)	9693 (202)	1490 (192)	164 (51)	5.57 (2.87)
Milo						
0-15 cm	450 (15)	446 (52)	9217 (75)	1457 (88)	68 (3.7)	1.54 (0.20)
20-30 cm	343 (2)	313 (25)	9813 (109)	1540 (138)	80 (10.8)	3.14 (0.82)
40-50 cm	157 (54)	271 (8)	9483 (229)	1557 (85)	191 (6.53)	13.15 (4.25)

( ) Standard error

Note: Samples taken from on the cane row in 3 plots in each of the control and milo treatment. Each sample consisted of 24 cores.

4.2 Harvest Data

Table 1: Cane Yield, Cane Quality and Sucrose Yield

Treatments	TC/ha			Suc % Cane			Suc T/ha		
	D_0	D_1	Mean	D_0	D_1	Mean	D_0	D_1	Mean
Control	74	74	74	16.89	15.67	16.28	12.5	11.6	12.0
Top Soil	77	98	88	16.36	16.94	16.65	12.6	16.6	14.6
River Sand	93	84	88	17.31	16.78	17.04	16.1	14.1	15.1
Milo	79	85	82	16.45	15.76	16.10	13.0	13.4	13.2
Gypsum	77	82	80	16.23	16.46	16.34	12.5	13.5	13.0
Mean	80	85	82	16.65	16.32	16.48	13.3	13.8	13.5
LSD Main Effects									
Treatment (0.05)		11			0.93			2.1	
(0.01)		15			1.26			2.9	
Drainage (0.05)		7			0.59			1.4	
(0.01)		10			0.80			1.85	
Significance									
Treatment		*			NS			*	
Drainage		NS			NS			NS	
Interaction (Treat. x Drainage)		NS			NS			NS	
LSD Specific effects (0.05)		16			1.31			3.0	
(0.01)		22			1.79			4.1	
SE One Plot		9			0.77			1.8	
CV %		11.3			4.7			13.1	

4.3 Leaf Analysis Data

Table 3: Third Leaf nutrient content at 3.7 months in February

Treatments	% dm						ppm
	N	P	K	S	Ca	Mg	Zn
Control	1.93	0.18	1.09	0.20	0.47	0.27	12.2
Top soil	1.91	0.18	1.15	0.19	0.45	0.27	13.3
River sand	1.92	0.18	1.11	0.20	0.42	0.25	13.3
Milo	1.95	0.20	1.22	0.20	0.41	0.26	12.8
Gypsum	1.90	0.18	1.11	0.21	0.46	0.26	12.7
LSD (0.05)	0.090	0.011	0.072	0.013	0.043	0.023	2.4
(0.01)	0.12	0.015	0.10	0.018	0.059	0.032	3.3
Significance	NS	**	**	NS	*	NS	NS
Mean	1.92	0.18	1.14	0.20	0.44	0.26	12.9
SE	0.074	0.009	0.059	0.010	0.035	0.019	2.0
CV %	3.8	4.7	5.2	5.3	8.0	7.2	15.3

Table 4: Third Leaf nutrient content at 5.5 months in April

Treatments	% dm				
	N	P	K	Ca	Mg
Control	1.89	0.24	1.13	0.47	0.27
Top soil	1.94	0.24	1.18	0.45	0.27
River sand	1.89	0.24	1.15	0.42	0.25
Milo	1.87	0.25	1.20	0.41	0.26
Gypsum	1.87	0.24	1.12	0.46	0.26
LSD (0.05)	0.093	0.085	0.085	0.054	0.0009
(0.01)	0.13	0.12	0.12	0.073	0.001
Significance	NS	NS	NS	NS	NS
Mean	1.89	0.24	1.16	0.46	0.21
SE one plot	0.077	0.011	0.073	0.049	0.015
CV %	4.1	4.4	6.3	10.7	7.2

5. COMMENTS

5.1 Soil Analysis

Vertical mulching with Milo increased OM %, P, K and Mg soil content while PDI and Ca were reduced. The effects tended to be most apparent in the first 30 cm (Table 1A and B).

5.2 Cane Yield

Cane yield in this trial has continually decreased and was particularly poor this season probably reflecting the effect of low rainfall and irrigation. Residual effects of vertical mulching on cane yield were apparent in all treatments. Responses were statistically significant where either top soil alone or river sand were fed down the profile. These results, however, must be viewed with caution as inspection of the data showed that in each of the topsoil and river sand treatments the better responses were due to one plot giving abnormally high yield.

Drainage tended to improve cane yield but the difference was not significant.

5.3 Cane Quality

The effects of treatments on sucrose content were variable and non significant.

Sucrose content tended to be lower in the presence of drainage but the difference was not significant.

5.4 Sucrose Yield

Sucrose yield reflected the effect of the treatments on cane yield. Responses were significant where either top soil or river sand were fed down the profile. In view of the data variability in these treatments it is felt that the main effects are more representative than the specific effects. Based on main effects, the best result in the 2nd ratoon appears to have been achieved by vertical mulching combined with river sand.

Sucrose yield tended to be better in presence of drainage but the difference was not significant.

5.5 Leaf Analysis

All nutrients were above NCo376 threshold except for P and Zn in February. There were significant differences in the content of P,K and Ca between milo and the control. P and K were higher while Ca was lower.

It is of interest to note that while in February P in the Milo was above NCo376 threshold, in the other treatments it was below threshold. Milo, however, did not give the best yield. The variety grown in this trial is N14 and it is known from the variety research programme that its leaf-P content is 10 to 15 % lower than NCo376. Hence the results of this trial tend to confirm that leaf-P threshold for N14 can be downgraded to a value of at least 0.18%.

6. CONCLUSION

* Results of this trial showed residual effects from vertical mulching especially when combined with river sand.

* Residual responses from the treatments can be summarized as follows: (Tons Sucrose ha^{-1})

	P	1stR	2ndR	Cumulated Responses
Top soil	-1.65 (-7.8)	0.1 (0.6)	2.6 (22)	1.05
River sand	-0.95 (-4.5)	1.4 (9.3)	3.1 (26)	3.55
Milo	2.3 (11.0)	1.9 (13.0)	1.2 (10)	5.4
Gypsum	-2.0 (-1.3)	-0.2 (-1.3)	1.0 (8)	-1.2

( ) % responses

* Foliar evidence and the fact that Milo did not achieve the best result in this ratoon further confirms that the beneficial effect of vertical mulching is related to improvement in either physical or hydrological properties. Measurements of these properties will be conducted next season.

* This trial has been continued and is now in its 3rd ratoon.

PCH/fkd
25.02.92

SOUTH AFRICAN SUGAR INDUSTRY
AGRONOMISTS' ASSOCIATION

EXPERIMENT RESULT

CODE: VM 4/88/Sw UBO 'V'
CAT No: 1711

TITLE: VERTICAL MULCHING IN SOILS WITH POOR PHYSICAL PROPERTIES

1. PARTICULARS OF PROJECT

This crop	:	3rd ratoon	Soil analysis: Date: 13/06/91
Site	:	Ubombo Ranches Field Citrus	pH 7.25; OM% 2.50; Clay% 66; Silt% 15; Sand% 18
Region	:	Northern Irrigated (Swaziland)	ppm: P 115; K 237; Ca 9682; Mg 1106; (Ca+Mg)/K 45
Design	:	Randomised Blocks 3 replications	CEC : 60.51 meq/100g soil
Soil Set	:	'V'	Dates : 11/11/91 - 19/11/92
Variety	:	N14	Age : 12.3 months
Fertilizer kg/ha	:	N 160 - P - K 150	Rainfall : 364 mm Irrigation: 1123 mm Total : 1487 mm

2. OBJECTIVES

2.1 To establish whether the practice of vertical mulching can improve production of sugarcane on soils which have poor physical properties.

2.2 To determine which of the most freely available materials (top-soil, sand or milo) is the more suitable to use as a vertical mulch.

2.3 To determine the importance of adequate drainage for vertical mulched crops.

3. TREATMENTS

The treatments were applied to the plant crop as follows:

3.1 Undrained (Do)

* Control - no mulching.
* Vertical mulching with top - soil fed down the profile.
* Vertical mulching with 150 tons/ha of river sand fed down the profile.
* Vertical mulching with 150 tons/ha of fresh milo fed down the profile.
* Vertical mulching with 10 tons/ha of gypsum fed down the profile.

3.2 Drained (D_1) - The vertical mulched channels were connected to sand filled slotted drains in an attempt to give a mole drain effect.

* Control - no mulching.
* Vertical mulching with only top-soil fed down the profile.
* Vertical mulching with 150 tons/ha river sand fed down the profile
* Vertical mulching with 150 tons/ha of fresh milo fed down the profile
* Vertical mulching with 10 tons/ha of gypsum fed down the profile

Notes on Treatments

* Planting ridges (as practised in Simunye) were made prior to the application of the treatments.
* Sand, milo and gypsum were evenly spread by hand into the furrow on top of the ridge in the appropriate plots and lightly incorporated with a rotary hoe prior to drawing the alubuster.
* The treatments with VM and top soil were also rotavated.
* Control plots were left undisturbed.

Notes on Fertilizer

* Nitrogen as Urea (46 % N) at the rate of 160 kg N/ha was banded on the cane row on 19/12/91 one month after harvest.
* Potassium as KCl (50% K) at the rate of 150 kg K/ha.

4. RESULTS

4.1 Leaf Analysis

Table 1: Third leaf nutrient content (%dm) at various ages

Treatments	February (3.0 months)					March (4.4 months)					April (5.1 months)				
	N	P	K	Ca	Mg	N	P	K	Ca	Mg	N	P	K	Ca	Mg
Control	1.78	0.22	0.91	0.37	0.26	1.61	0.21	0.94	0.35	0.26	1.58	0.21	0.93	0.34	0.26
Topsoil	1.79	0.21	0.94	0.46	0.25	1.63	0.21	0.95	0.36	0.26	1.60	0.21	0.99	0.35	0.23
150 t/ha river sand	1.74	0.21	0.88	0.37	0.25	1.54	0.21	0.92	0.35	0.24	1.57	0.20	1.03	0.33	0.25
150 t/ha milo	1.72	0.23	0.99	0.30	0.24	1.60	0.22	1.00	0.32	0.23	1.57	0.22	1.12	0.34	0.24
10 t/ha Gypsum	1.78	0.23	0.99	0.36	0.23	1.61	0.21	1.02	0.32	0.26	1.56	0.22	0.97	0.34	0.22
LSD (0.05)	0.09	0.02	0.13	0.15	0.04	0.09	0.02	0.09	0.05	0.04	0.10	0.02	0.17	0.07	0.04
Significance	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Mean	1.76	0.22	0.94	0.37	0.25	1.60	0.21	0.97	0.34	0.25	1.58	0.21	1.01	0.34	0.24
SED	0.04	0.01	0.06	0.07	0.02	0.04	0.01	0.04	0.03	0.02	0.05	0.01	0.08	0.03	0.02
CV%	4.0	6.1	11.6	32.9	12.9	4.3	7.3	7.9	13.9	13.3	5.3	5.9	13.6	15.3	14.3

4.2 Harvest Data

Table 2: Cane Yield, Cane Quality and Sucrose Yield

Treatments	TC/ha			Suc % Cane			Suc T/ha		
	Do	D1	Mean	Do	D1	Mean	Do	D1	Mean
Control	107	101	104	15.31	16.15	15.73	16.4	16.3	16.4
Top Soil	109	110	109	15.37	15.94	15.65	16.7	17.5	17.1
150 t/ha river sand	122	111	117	15.35	15.74	15.55	18.7	17.4	18.1
150 t/ha milo	121	115	118	14.84	15.44	15.14	18.0	17.7	17.9
10 t/ha Gypsum	114	106	110	14.82	15.42	15.12	16.9	16.5	16.7
Mean	115	108	112	15.14	15.74	15.44	17.3	17.1	17.2
LSD Treatment (0.05)	15			0.57			2.4		
SED ±	7			0.27			1.1		
Drainage (0.05)	9			0.36			1.5		
SED ±	4			0.17			0.7		
Significance - Treatment	NS			NS			NS		
Drainage	NS			**			NS		
Interaction (Treatment x Drainage)	NS			NS			NS		
LSD Specific effects (0.05)	21			0.80			3.3		
SED ±	10			0.38			1.6		
CV %	10.9			3.0			11.3		

5. COMMENTS

5.1 Soil Analysis

Soil analysis results for samples taken 4.9 months before harvesting the 2nd ratoon in 1991, have been used as the basis for the nutritional status of the soil in the 3rd ratoon. Soil-P and soil K status were satisfactory and above threshold. However, the (Ca+Mg)/K ratio was very high, owing to high levels of Ca and Mg, which could have limited uptake of K.

5.2 Leaf Analysis

Leaf analysis in February, March and April showed levels of all nutrients to be satisfactory and above threshold for N14. Nitrogen appeared to be marginal to deficient according to NCo376 thresholds in March and April. However, evidence from variety trials suggests that N content is only 94% of NCo376 levels and these levels appear satisfactory for N14. During this period, the milo treatment was observed to be low in the contents of N, Ca and Mg, but high in P and K compared to the control. Differences between the treatments were not statistically significant (table 1).

5.3 Harvest Data

5.3.1 Cane Yield

Cane yields were considerably higher than last year and were improved by vertical mulching. Yield responses were greatest in the case of VM + sand or Milo but did not reach a level of statistical significance. Drainage appeared to cause a reduction in yield but this effect was variable and was also not statistically significant.

5.3.2 Cane Quality

Sucrose content of the vertically mulched treatments tended to be lower than the control although the effect was not statistically significant. Sucrose was consistently higher where drainage occurred and this effect was statistically significant.

5.3.3 Sucrose yield

There were no statistically significant differences in sucrose yields although VM + sand or Milo increased sucrose yield by 1.7 tons and 1.5 tons of sucrose respectively. Drainage had no clear effect on sucrose yields.

6. CONCLUSION

* Results of this 3rd ratoon crop have indicated that there were still residual effects of vertical mulching with either sand or Milo in the plant crop although the responses were no longer statistically significant.

* Residual responses can be summarized as follows (Tons sucrose/ha).

	P	1R	2R	3R	Cumulated Resp.
Top soil	-1.65	0.1	2.6	0.7	1.8
River sand	-0.95	1.4	3.1	1.7	5.2
Milo	2.3	1.9	1.2	1.5	6.9
Gypsum	-2.0	-0.2	1.0	0.3	-0.9

* There were no effects of drainage on sucrose yields in this crop.

* This trial has been continued to determine the longevity of the beneficial effects of vertical mulching.

DMZ/vnm
15.02.93

SOUTH AFRICAN SUGAR INDUSTRY AGRONOMISTS' ASSOCIATION

Cat. No.: 1711

CODE: VM 4/88/SW/Ubo 'V'

TITLE: VERTICAL MULCHING IN SOILS WITH POOR PHYSICAL PROPERTIES

1. PARTICULARS OF PROJECT

This crop	: 4th Ratoon				
Site	: Ubombo Ranches Field Citrus				
Region	: Northern Irrigated (Swaziland)				
Soil Set	: 'V'				
Design	: Randomised Blocks 3 replications				
Variety	: N14				
Fertilizer (kg/ha)	: N :160	P -	K 150		

Soil Analysis: Date 01/12/92				
pH	OM%		Clay %	
7.4	2.5		66	
ppm (control)				
P	K	Ca	Mg	(Ca+Mg)/K
113	236	9374	1249	48
CEC	: 60.51 meq/100g soil			
Age	: 12.2 months			
Dates	: 19/11/92 - 26/11/93			
Rainfall	: 195 mm			
Irrigation	: 1076 mm (overhead)			
Total	: 1271 mm			

2. OBJECTIVES

2.1 To establish whether the practice of vertical mulching can improve production of sugarcane on soils which have poor physical properties.

2.2 To determine which of the most freely available materials (top-soil, sand or milo) is the more suitable to use as a vertical mulch.

2.3 To determine the importance of adequate drainage for vertical mulched crops.

3. TREATMENTS

The following treatments were applied to undrained (Do) and drained (D1) subtreatments in the plant crop. In the drained subtreatments the vertical mulched channels were connected to sand filled slotted drains to create a mole drain effect.

1. Control - no mulching.
2. Vertical mulching with top soil fed down the profile.
3. Vertical mulching with 150 tons/ha of river sand fed down the profile.
4. Vertical mulching with 150 tons/ha of fresh milo fed down the profile.
5. Vertical mulching with 10 tons/ha of gypsum fed down the profile.

3.1 Notes on Treatments

Planting ridges (as practised in Simunye) were made prior to the application of treatments.

Sand, milo and gypsum were evenly spread by hand into the furrow on top of the ridge in the appropriate plots and incorporated with a rotary hoe prior to drawing the alubuster (implement with which mulching material was fed down the soil profile).

The VM + top soil treatment was also rotavated.

Control plots were left undisturbed.

3.2 Notes on Fertilizers

Nitrogen (Urea, 46% N) at 160kg N/ha was banded on the cane row 2 weeks after harvest.

Potassium (KCl, 50% K) at 150kg K/ha was broadcast 2 weeks after harvest.

3.3 Notes on Soil Sampling

Topsoil: 40 cores were taken from each plot at a ratio of 16 on row to 24 interrow (i.e. 1:1.5) 2 weeks after harvest.

Subsoil: 20 cores were taken from 3 selected plots in the control and milo treatment at a ratio on 8 on row to 12 interrow (1:1.5), 2 weeks after harvest.

4. RESULTS

4.1 Soil Analysis

Table 1: P, K, Ca and Mg status (ppm) of the topsoil - December 1992

	P			K			Ca			Mg			(Ca+Mg)/K		
Treatment	D0	D1	Mean	D0	D1	Mean	D0	D1	Mean	D0	D1	Mean	D0	D1	Mean
Control	76	61	69	252	207	229	9240	9967	9603	1364	1284	1324	45	56	50
VM + topsoil	67	187	127	240	194	217	9723	8973	9348	1294	1470	1382	47	54	50
VM + river sand	68	65	66	254	246	250	8750	8043	8397	1094	1260	1177	41	43	42
VM + milo	173	177	175	287	251	269	9107	0117	9612	1301	1317	1309	41	49	45
VM + gypsum	160	94	127	209	217	213	9717	0103	9910	1100	1001	1050	52	52	52
Mean	109	117	113	248	223	236	9307	9441	9374	1231	1266	1249	45	51	48

Table 2: K, Ca and Mg status (ppm) of the soil profile - December 1992

Depth	Control					150 tons/ha Milo				
(cm)	P	K	Ca	Mg	(Ca+Mg)/K	P	K	Ca	Mg	(Ca+Mg)/K
0 - 15	59	251	9580	1143	43	103	254	9787	1265	44
20 - 30	30	204	9567	1305	53	87	231	10413	1339	51
40 - 50	18	192)	9313	1510	56	42	191	9260	1422	56

4.2 Leaf Analysis

Table 3: Third leaf nutrient analysis (% dm) in February at 2.8 months

Treatment	N			P			K			Ca			Mg		
	D0	D1	Mean	D0	D1	Mean	D0	D1	Mean	D0	D1	Mean	D0	D1	Mean
Control	1.94	1.83	1.89	0.22	0.21	0.22	0.78	0.95	0.86	0.53	0.50	0.52	0.34	0.28	0.31
VM + topsoil	1.97	1.91	1.94	0.20	0.21	0.20	0.83	0.90	0.87	0.54	0.49	0.52	0.32	0.30	0.31
VM + river sand	1.91	1.89	1.90	0.21	0.20	0.21	0.93	0.88	0.90	0.45	0.53	0.49	0.28	0.30	0.29
VM + milo	1.88	1.97	1.93	0.22	0.21	0.22	0.94	0.90	0.92	0.41	0.52	0.46	0.28	0.30	0.29
VM + gypsum	1.91	1.93	1.92	0.21	0.21	0.21	0.85	0.85	0.85	0.49	0.47	0.48	0.30	0.31	0.31
Mean	1.92	1.91	1.92	0.21	0.21	0.21	0.87	0.90	0.88	0.49	0.47	0.49	0.31	0.30	0.30

4.3 Growth Data

Table 4: Cane measurements at 2.6 and 8.2 months of age

Treatment	Stalk height (cm to TVD)		Stalk population (*1000/ha)	
	February (2.6 m)	July (8.2 m)	February (2.6 m)	July (8.2 m)
Control	50	196	254	119
VM + topsoil	48	196	252	119
VM + river sand	48	201	259	122
VM + milo	50	208	247	126
VM + gypsum	51	193	249	110
Mean	49	199	252	119

4.4 Harvest Data

Table 5: Cane yield, sucrose % cane and sucrose yield

Treatment	Tons Cane/ha			Sucrose % Cane			Tons Sucrose/ha		
	D0	D1	Mean	D0	D1	Mean	D0	D1	Mean
Control	56	53	55	14.65	14.89	14.77	8.2	8.0	8.1
VM + topsoil	56	60	58	14.50	15.11	14.81	8.2	9.1	8.6
VM + river sand	63	55	59	14.83	14.86	14.84	9.4	8.3	8.8
VM + milo	61	62	61	14.39	14.58	14.49	8.7	9.2	8.9
VM + gypsum	61	57	59	14.41	15.00	14.71	8.9	8.5	8.7
Mean	59	57	58	14.56	14.89	14.72	8.7	8.6	8.6
LSD Treatment (0.05)		10			0.43			1.6	
SED ±		4.9			0.21			0.8	
LSD Drainage (0.05)		7			0.27			1.0	
SED ±		3.1			0.13			0.5	
Significance: Treatment		NS			NS			NS	
Drainage		NS			NS			NS	
Interaction (Treatment * Drainage)		NS			NS			NS	
LSD Specific Eff. (0.05)		15			0.61			2.3	
SED ±		6.9			0.29			1.1	
CV %		14.5			2.4			15.4	

5. COMMENTS

5.1 Soil Analysis

Soil analysis in December 1992 before fertilizers were applied showed that levels of Phosphorus and Potassium were satisfactory under these conditions (table 1). Vertical mulching with milo and gypsum significantly increased soil P and Ca levels.

5.2 Leaf Analysis

Third leaf nutrient analysis in February at 2.8 months of age showed that N and P levels were satisfactory but that K was deficient in spite of high soil K levels (table 3).

Treatments of vertical mulching, particularly with milo, tended to increase N, P, and K content in the early stages of growth. The effects were not always statistically significant.

5.3 Growth Data

Both stalk heights and populations tended to be higher in the VM+milo treatments, particularly in the later stages of growth, although these differences were not statistically significant (table 4).

5.4 Harvest Data

Cane yields were very low in this 4th ratoon of this trial, probably owing to the prevalent drought conditions in the past season (table 5). Yield responses to VM and drainage were small, inconsistent and were not statistically significant. The milo treatment was only slightly better than the other treatments.

Vertical mulching treatments and drainage had no statistically significant effect on sucrose content.

Sucrose yields were low this year compared to that of the previous crop due to low cane yields. Vertical mulching treatments and drainage had no statistically significant effect on sucrose yield.

6. CONCLUSIONS

- Even though cane and sucrose yields were low in this crop, residual benefits to vertical mulching with milo and river sand were observed but were no longer statistically significant.

- The residual effects of vertical mulching treatments (TSuc/ha) can be summarised as follows:

Treatment	1st R	2nd R	3rd R	4th R	Cumulated Resp.
VM + topsoil	0.1	2.6	0.7	0.5	2.3
VM + river sand	1.4	3.1	1.7	0.7	6.0
VM + milo	1.9	1.2	1.5	0.8	7.7
VM + gypsum	-0.2	1.0	0.3	0.6	-0.3

- Drainage had no statistically significant effect on sucrose yields of the different treatments under these conditions.

- This trial has been terminated and a summary of results for the plant crop to 4th ratoon is attached.

DMZ/fkn
13.01.94

TERMINAL REPORT SUMMARY: VM4/88/SW/Ubo 'V'
Plant to 4th ratoon

Table 1: Soil analysis - plant to 4th ratoon

a) Nutrient status (ppm) of the soil

Season	Crop	Analysis date	ppm						
			P	K	S	Ca	Mg	Zn	Na
1988/89	Plant	19/12/89	50	261	241	9760	1142	3	422
1989/90	1st R	19/12/89	50	261	241	9760	1142	3	422
1990/91	2nd R	13/06/91	115	237	241	9682	1106	-	-
1991/92	3rd R	13/06/91	115	237	241	9682	1106	-	-
1992/93	4th R	01/12/92	113	236	241	9374	1249	-	-

b) Effect of milo on chemical and physical properties of the soil profile

Season	Crop	Analysis Date	Treatment	Depth (cm)	pH	OM%	Clay %	CEC/100g soil	KDI	PDI	EC MS/m	SAR
1990/91	2nd R	May 1991	Control	0-15	7.3	2.5	-	60.7	0.64	0.50	87	1.83
				20-30	7.4	2.4	-	63.3	0.71	0.33	138	3.80
				40-50	7.4	2.2	-	64.3	0.69	0.27	164	5.57
			Milo	1-15	7.3	3.8	65.7	60.3	0.64	0.06	68	1.54
				21-30	7.5	3.0	65.6	64.3	0.65	0.41	80	3.14
				41-50	7.7	2.4	66.8	64.0	0.76	0.28	191	13.15

Table 2: Rainfall and irrigation figures plant to 4th ratoon

Crop	Season	Period	Rainfall (mm)	Irrigation (mm)	Total (mm)
Plant	1988/89	20/09/88-24/11/89	513	1041	1554
1st R	1989/90	24/11/89-10/11/90	259	772	1031
2nd R	1990/91	10/11/90-11/11/91	282	619	901
3rd R	1991/92	11/11/91-19/11/92	364	1123	1487
4th R	1992/93	19/11/92-26/11/93	195	1076	1271
Mean			323	926	1249

Table 3: Third leaf nutrient analysis (% dm) at various ages - plant to 4th ratoon

Season	Crop	Month sampled	Age (mths)	Nutrient	Treatment				Mean
					Control	VM + soil	VM + sand	VM + gypsum	
1988/89	Plant	Jan	3.7	N	2.00	2.04	1.97	2.02	2.04
		Feb	5.1		1.72	1.71	1.60	1.72	1.72
		Jan	3.7	P	0.24	0.23	0.22	0.23	0.23
		Feb	5.1		0.19	0.20	0.19	0.19	0.20
		Jan	3.7	K	1.25	1.10	1.32	1.23	1.29
		Feb	5.1		1.33	1.31	1.29	1.36	1.30
		Jan	3.7	Ca	0.37	0.39	0.37	0.40	0.30
		Feb	5.1		0.29	0.29	0.29	0.30	0.20
		Jan	3.7	Mg	0.21	0.21	0.20	0.21	0.21
		Feb	5.1		0.19	0.20	0.19	0.19	0.19
1989/90	1R	Feb	2.3	N	1.91	1.93	1.95	1.92	1.92
		Apr	4.4		1.77	1.73	1.77	1.70	1.77
		Feb	2.3	P	0.22	0.22	0.22	0.22	0.23
		Apr	4.4		0.19	0.20	0.20	0.20	0.20
		Feb	2.3	K	1.25	1.21	1.22	1.24	1.27
		Apr	4.4		1.21	1.23	1.21	1.27	1.26
		Feb	2.3	Ca	0.35	0.33	0.34	0.34	0.33
		Apr	4.4		0.32	0.31	0.32	0.32	0.31
		Feb	2.3	Mg	0.24	0.24	0.24	0.23	0.24
		Apr	4.4		0.19	0.19	0.20	0.19	0.19
			3.7	N	1.93	1.91	1.92	1.90	1.92
			3.7	P	0.18	0.18	0.18	0.18	0.18
1990/91	2R	Feb	3.7	K	1.09	1.15	1.11	1.11	1.14
			3.7	Ca	0.47	0.45	0.42	0.46	0.44
			3.7	Mg	0.27	0.27	0.25	0.26	0.26
1991/92	3R	Feb	3.0	N	1.70	1.79	1.74	1.70	1.76
		Mar	4.4		1.61	1.63	1.54	1.61	1.60
		Feb	3.0	P	0.22	0.21	0.21	0.23	0.22
		Mar	4.4		0.21	0.21	0.21	0.21	0.21
		Feb	3.0	K	0.91	0.94	0.88	0.99	0.94
		Mar	4.4		0.94	0.95	0.92	1.02	0.97
		Feb	3.0	Ca	0.37	0.46	0.37	0.36	0.37
		Mar	4.4		0.35	0.36	0.35	0.32	0.34
		Feb	3.0	Mg	0.26	0.25	0.25	0.23	0.25
		Mar	4.4		0.26	0.26	0.24	0.26	0.25
1992/93	4R	Jan	1.0	N	2.03	2.10	2.16	2.14	2.12
		Feb	2.0		1.09	1.94	1.90	1.92	1.92
		Jan	1.0	P	0.29	0.29	0.20	0.29	0.29
		Feb	2.0		0.22	0.20	0.21	0.21	0.21
		Jan	1.0	K	0.60	0.72	0.60	0.75	0.74
		Feb	2.0		0.86	0.87	0.90	0.85	0.90
		Jan	1.0	Ca	1.32	1.30	1.22	1.27	1.20
		Feb	2.0		0.52	0.52	0.49	0.40	0.49
		Jan	1.0	Mg	0.54	0.52	0.50	0.50	0.50
		Feb	2.0		0.31	0.31	0.29	0.31	0.30

Table 4: Cane yield, sucrose % cane and sucrose yield, plant to 4th ratoon

Cane yield (t/ha)												
	1989		1990		1991		1992		1993		Mean	
	D0	D1	D0	D1	D0	D1	D0	D1	D0	D1	D0	D1
Control	136	125	99	100	74	74	107	101	56	53	94	91
VM + soil	124	113	100	102	77	98	109	110	56	60	95	97
VM + sand	135	117	110	110	93	84	122	111	63	55	105	95
VM + milo	146	151	110	115	79	85	121	115	61	62	103	106
VM + gypsum	118	119	101	100	77	82	114	106	61	57	94	93
Sucrose % cane												
	1989		1990		1991		1992		1993		Mean	
	D0	D1	D0	D1	D0	D1	D0	D1	D0	D1	D0	D1
Control	15.7	16.5	15.1	15.0	16.9	15.7	15.3	16.2	14.7	14.9	15.5	15.7
VM + soil	15.2	16.0	14.8	15.0	16.4	16.9	15.4	15.9	14.5	15.1	15.5	15.8
VM + sand	15.4	16.5	15.0	14.9	17.3	16.9	15.4	15.7	14.8	14.9	15.6	15.8
VM + milo	15.2	16.3	14.5	15.5	16.5	15.7	14.8	15.4	14.4	14.6	15.1	15.5
VM + gypsum	15.3	16.7	15.0	14.6	16.2	16.6	14.8	15.4	14.4	15.0	15.1	15.2
Sucrose yield (t/ha)												
	1989		1990		1991		1992		1993		Mean	
	D0	D1	D0	D1	D0	D1	D0	D1	D0	D1	D0	D1
Control	21.4	20.6	15.0	15.0	12.5	11.6	16.4	16.3	8.2	8.0	14.7	14.3
VM + soil	20.1	18.6	14.8	15.4	12.6	16.6	16.7	17.5	8.2	9.1	14.5	15.4
VM + sand	20.8	19.3	16.6	16.3	16.1	14.1	18.7	17.4	9.4	8.3	16.3	15.1
VM + milo	22.1	24.5	16.0	17.8	13.0	13.4	18.0	17.7	8.7	9.2	15.6	16.5
VM + gypsum	18.1	19.9	15.1	14.5	12.5	13.5	16.9	16.5	8.9	8.5	14.3	14.6

Note: D0 = No drains installed
D1 = Drains installed