

THE PERFORMANCE OF SUGARCANE VARIETIES N23 AND N25 ON LOW YIELD POTENTIAL SOILS IN SWAZILAND

DWF BUTLER

Swaziland Sugar Association, PO Box 367, Simunye, Swaziland

Abstract

South African sugarcane varieties N23 and N25 were compared against industry standards NCo376 and N19 on soils with low yield potential in four replicated, irrigated trials comprising a total of 17 crops, harvested either early, mid or late in the milling season. Chemical ripeners ethephon (2-chloroethane-phosphonic acid) and Fusilade Super (fluazifop-p-butyl) were applied either alone or as a combination treatment in two early season experiments, while Fusilade Super, ethephon or Kadostim was applied in one mid season experiment when conditions allowed.

These varieties tended not to respond strongly to chemical ripeners when grown on poor soils. This was probably because of poor growing conditions when ripeners were applied and variable soil conditions across the trial sites. The mean sucrose yield of N25 was consistently higher than that of varieties N23 and NCo376 in early, mid and late season experiments, indicating that N25 is better suited to poor soil conditions than the current industry standards. Variety N19 also yielded more sucrose per hectare than N23 and NCo376 in early and mid season experiments. The potential of variety N23 may be restricted to more productive soils, where it responds well to chemical ripeners.

Key words: varieties, chemical ripeners, Swaziland, *Saccharum* spp

Introduction

Since the late 1980s, a major function of the Extension Services of the Swaziland Sugar Association has been to import newly released smut-tolerant sugarcane varieties from the South African Sugar Association Experiment Station (SASEX) and to evaluate their performance in the Swaziland lowveld. In an on-going programme, the varieties are planted in a series of replicated field trials, representing potential combinations of soil type and season of harvest as fully as possible. In all of these variety trials, NCo376 treated with chemical ripeners is included as a standard against which newer varieties must compare favourably and consistently if they are to be recommended to the industry.

Rostron *et al.* (1999) reported results of four of these trials on good to moderate soils in the Swaziland lowveld, harvested in the early part of the milling season (June/July). They concluded that the relatively low sucrose, high cane yielding varieties N23 and N25 compared most favourably with chemically ripened NCo376 under these conditions, especially when they were also chemically ripened. This paper reports the results of four replicated trials from the same on-going programme, comprising three plant and up to five ratoon crops, located on soils with low yield

potential and harvested either early, mid or late in the milling season.

Procedure

Four replicated field trials (experiments 1 to 4) were established on sites representing soils of low yield potential between 1992 and 1998. The soils were characterised by poor drainage and weakly structured topsoil. N23 was planted once on a C set soil (experiment 1, Canterbury or Bonheim form) and once on a Z set soil (experiment 2, Zwibe or Katspruit form) (after Nixon *et al.*, 1986). N25 was planted in two trials on Z set soils (experiments 2 and 3) and once on a C set soil (experiment 4). Experiments were harvested at approximately 12 months of age over a period of two to six years. Gross plot size ranged from 162 to 114 m² and net plot size from 96 to 51 m². All crops were fully irrigated. Experiments 2 and 3 were furrow irrigated, while experiments 1 and 4 were sprinkler irrigated. Harvest dates, soil types and varieties tested in each experiment are given in Table 1.

Variety NCo376 was the standard in all four experiments, while N19 was included in experiments 1 and 3 because of its popularity on poor soils harvested early to mid season (Ndlovu, 2001). Results from varieties N22, N24, N28 and N30 have been excluded. Varieties N22 and N24 have not performed well in Swaziland (Rostron *et al.*, 1999) while there are only limited data from varieties N28 and N30.

Details of ripener treatments in all trials are shown in Table 2. One crop in experiment 1 was not treated because the cane was not growing vigorously at the scheduled time of application. The co-operators accidentally over-sprayed another crop in experiment 2 with ethephon, and the results have been excluded.

The mid and late season experiments were designed to accommodate two ripener treatments, usually comprising Fusilade Super at two different rates, and an untreated control. However, crop conditions were rarely suitable for ripener application and only two out of eight mid and late season trial crops were chemically ripened for experimental purposes. One crop in experiment 3 was ripened with either ethephon or Kadostim, an untested chemical growth regulator. A second crop was accidentally over-sprayed with ethephon by the co-operators.

Procedures for fertiliser and chemical ripener application, sucrose sampling, harvesting and yield measurements are described in Rostron *et al.* (1999).

Results And Discussion

Early season experiments

Sucrose sampling before ripener application revealed a bias in stalk fresh weight towards the untreated control plots in both

Table 1. Details of soil type, varieties and harvesting dates for each experiment.

Experiment	Soil type	Varieties	Harvest date					Mean age at harvest (m)	
			Plant crop	1R	2R	3R	4R		5R
1	Ca ¹	NCo376 N19 N22 N23	28-Jul-93	14-Jun-94	15-Jun-95	19-Jun-96	26-Jun-97	-	11.5
2	Zd ²	NCo376 N23 N25	28-May-96	12-Jul-97	03-Jul-98	22-Jun-99	22-Jun-00	-	12.5
3	Zd ²	NCo376 N19 N24 N25	30-Aug-95	28-Sep-96	28-Oct-97	24-Sep-98	31-Aug-99	12-Sep-00	12.1
4	Ca ¹	NCo376 N25 N28 N30	04-Oct-99	30-Nov-00	-	-	-	-	13.3

Ca¹ = Canterbury series, Zd² = Zwide series

experiments, reflecting poor soil uniformity across the trial sites. This affected the results of both experiments, leading to large variability in cane and sucrose yields in some crops and making comparisons between ripened or unripened varieties unreliable (Table 3).

Chemical ripeners significantly increased mean sucrose per cent cane (fresh weight) in four out of four crops in experiment 1 (Table 3). These increases were associated with improvements in sucrose per cent dry matter in all three varieties, indicating that there was a true ripening effect (Table 4). However, the interaction between ripeners and varieties was rarely statistically significant, either in terms of sucrose per cent cane (fresh weight) or sucrose per cent dry matter.

The effect of chemical ripeners on cane yield was exaggerated by the variable soil conditions across the trial site and was inconsistent with previous results (Rostron, 1985; Rostron, 1996; Rostron *et al.*, 1999). This effect negated any clear benefit of ripeners in terms of sucrose yield.

Cane yields were inconsistent with ripener treatments in experiment 2, reflecting the poor uniformity of the trial site (Table 3). Juice purity was generally too high to expect a strong response to either ethephon or Fusilade Super (Table 5) (after Rostron, 1975) and increases in cane quality were small (Tables 3 and 4). Once again the effect of soil variation negated any ripener benefits in terms of sucrose yield.

Varieties N19 and N25 produced higher mean sucrose yields than NCo376 and N23 in these early season experiments, although varietal differences in sucrose yield were statistically significant in only four out of nine crops overall. The differences were due to superior mean cane yields in N25 and superior cane quality in N19. The yield performance of varieties NCo376 and N23 was generally similar, supporting the results of experiments on more productive soils (Rostron *et al.*, 1999).

Variations in stalk fresh weight, cane yield and response to ripeners may have been caused by moisture stress or water logging in areas of both trials, especially when ripener treatments were applied. This is probably a fair reflection of commercial field conditions on C and Z set soils where yield potential is limited by poor and irregular drainage or infiltration across the field (Nixon *et al.*, 1986). Mean results suggest that varieties N19 and N25 are better suited to these conditions than NCo376, each yielding an average of 7% more sucrose in early season experiments (Table 6). Varieties N23 and NCo376 are more appropriate for conditions where the response to chemical ripeners is more consistent and reliable (Rostron *et al.*, 1999).

Mid and late season experiments

Chemical ripeners were not applied or were ineffective in mid and late season experiments because of the advanced maturity of the crop when treatments were scheduled (Table 6). However, ethephon significantly reduced sucrose per cent cane (fresh weight) in N25 in the second ratoon of experiment 3.

Cane and sucrose yield results were highly variable in the plant crop of experiment 3, when the coefficients of variation (CV) exceeded 19% (Table 3). Results of other crops in experiments 3 and 4 were generally more uniform than those of the early season experiments. They indicated that N25 is better suited to mid and late season harvest on poor soils than either N19 or NCo376, yielding an average of 20% more sucrose than NCo376 and 10% more sucrose than N19 (Table 6). The high sucrose yield of N25 was associated with a high cane yield and relatively low cane quality in experiment 3, confirming results from better soils (Rostron *et al.*, 1999).

The unripened sucrose yield of N25 was almost 4 ts/ha/annum higher than that of NCo376 averaged over both crops of experiment 4. The difference was due to superior cane yields and cane quality in N25 (Table 3), and is notably greater than that reported by Rostron *et al.* (1999) in an early season cycle on

Table 2. Details of chemical ripener treatments for each experiment.

Experiment	Chemical ripener treatments					
	Plant crop	1R	2R	3R	4R	5R
1	Ripeners not applied (unsuitable crop condition)	Control E 1.5 l/ha + F 0.3 l/ha E 1.3 l/ha + F 0.45 l/ha	Control E 1.5 l/ha + F 0.3 l/ha E 1.3 l/ha + F 0.45 l/ha	Control E 1.5 l/ha + F 0.3 l/ha E 1.5 l/ha + F 0.45 l/ha	Control E 1.5 l/ha + F 0.3 l/ha E 1.5 l/ha + F 0.45 l/ha	-
2	E 1.5 l/ha * E 1.5 l/ha + F 0.3 l/ha * E 1.5 l/ha + F 0.45 l/ha * E 1.5 l/ha + F 0.6 l/ha *	Control E 1.5 l/ha F 0.45 l/ha E 1.5 l/ha + F 0.45 l/ha	Control E 1.5 l/ha F 0.45 l/ha E 1.5 l/ha + F 0.45 l/ha	Control E 1.5 l/ha F 0.45 l/ha E 1.5 l/ha + F 0.45 l/ha	Control E 1.5 l/ha F 0.45 l/ha E 1.5 l/ha + F 0.45 l/ha	-
3	Ripeners not applied (unsuitable crop condition)	Ripeners not applied (unsuitable crop condition)	Control E 1.5 l/ha K 1.0 l/ha	Control F 0.3 l/ha F 0.45 l/ha	E 1.35 l/ha * E 1.35 l/ha * E 1.35 l/ha *	Ripeners not applied (unsuitable crop condition)
4	Ripeners not applied (unsuitable crop condition)	Ripeners not applied (unsuitable crop condition)	-	-	-	-

E = ethephon, applied as Ethrel (480g ai/l) 10 to 26 weeks before harvest

F = Fusilade Super (125g ai/l) applied 6 to 11 weeks before harvest K = Kadostim applied 26 weeks before harvest

* trial over-sprayed with Ethrel by co-operators

more productive soils. Experiment 4 will be continued to extend the comparison between varieties N25 and NCo376 over more ratoons.

Conclusions

- Cane and sucrose yield results of the two early season experiments were highly variable because soil conditions at the trial sites were not uniform. This made comparisons between unripened or ripened varieties unreliable, indicating that the standard experimental design did not adequately account for the variation inherent in these soils.
- Varieties N19 and N25 produced higher mean sucrose yields than NCo376 and N23 in two chemically ripened early season experiments. This was due to superior cane yields in N25 and superior cane quality in N19, although differences were rarely statistically significant.
- The mean cane quality of varieties was improved by treatment with ethephon and Fusilade Super in early season experiments, depending on the maturity of the crop. However, the interaction between ripeners and varieties was rarely statistically significant in terms of sucrose per cent cane (fresh weight) or sucrose per cent dry matter. Ripening benefits were nullified in terms of sucrose yield because of variable soil effects on cane yield in both experiments.
- Chemical ripeners were not applied or were ineffective in mid and late season experiments because of the advanced maturity of the crop when treatments were scheduled.
- Variety N25 produced more sucrose per hectare than variety NCo376 in mid and late season experiments. This was due

to superior cane yields in the mid season experiment and superior cane yields and quality in the late season experiment. Variety N25 also out-yielded N19 in the mid season trial due to superior cane yields and despite inferior quality.

- The yield performance of varieties N19 and N25 is possibly less dependent on a strong response to chemical ripeners than that of NCo376 and N23, making them more suitable for adverse growing conditions.

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Table 3. Average harvest results for all crops of each experiment (annualised).

Experiment 1	Tc/ha			S% cane			Ts/ha								
	Control	E+F0.3	E+F0.45	Mean	Control	E+F0.3	E+F0.45	Mean	Control	E+F0.3	E+F0.45	Mean			
NC0376	133.9	125.9	106.9	122.2	14.3	15.7	15.9	15.3	19.1	19.7	17.0	18.6			
N19	128.5	126.0	118.2	124.2	15.5	16.3	16.4	16.1	19.9	20.5	19.4	19.9			
N23	130.3	123.2	120.6	124.7	14.3	15.6	16.0	15.3	18.6	19.2	19.3	19.1			
Mean	130.9	125.1	115.2	123.7	14.7	15.8	16.1	15.5	19.2	19.8	18.6	19.2			
Significance	1 out of 5 crops				3 out of 5 crops				2 out of 5 crops						
"	3 out of 4 crops				4 out of 4 crops				1 out of 4 crops						
"	1 out of 4 crops				1 out of 4 crops				1 out of 4 crops						
CV % (range)	11.8 - 14.5				3.9 - 6.2				9.2 - 14.7						
Experiment 2	Tc/ha			S% cane			Ts/ha								
	Control	E1.5	F0.45	E+F0.45	Mean	Control	E1.5	F0.45	E+F0.45	Mean	Control	E1.5	F0.45	E+F0.45	Mean
NC0376	90.5	89.5	79.2	86.3	86.4	15.1	15.5	15.8	15.9	15.6	13.7	13.9	12.5	13.7	13.5
N23	88.9	85.8	86.0	84.2	86.2	14.8	15.2	15.4	15.6	15.3	13.2	13.1	13.3	13.1	13.2
N25	89.4	94.8	100.5	99.6	96.1	14.9	14.7	15.0	15.4	15.0	13.4	14.0	15.0	15.3	14.4
Mean	89.6	90.0	88.6	90.0	89.6	15.0	15.2	15.4	15.6	15.3	13.4	13.6	13.6	14.1	13.7
Significance	2 out of 4 crops					2 out of 4 crops				2 out of 4 crops					
"	0 out of 4 crops					2 out of 4 crops				0 out of 4 crops					
"	0 out of 4 crops					1 out of 4 crops				0 out of 4 crops					
CV % (range)	6.9 - 17.6					2.7 - 7.8				9.4 - 18.2					
Experiment 3	Tc/ha			S% cane			Ts/ha								
	Control	E or F0.3	K or F0.45	Mean	Control	E or F0.3	K or F0.45	Mean	Control	E or F0.3	K or F0.45	Mean			
NC0376	118.0	111.2	110.1	113.1	16.6	16.2	17.0	16.6	19.5	17.9	18.8	18.7			
N19	116.0	104.6	118.9	113.2	17.4	17.6	17.8	17.6	20.2	18.4	21.1	19.9			
N25	123.5	129.9	145.3	132.9	16.7	16.3	16.2	16.4	20.7	21.2	23.6	21.8			
Mean	119.2	115.2	124.8	119.7	16.9	16.7	17.0	16.9	20.1	19.2	21.2	20.2			
Significance	4 out of 6 crops				5 out of 6 crops				4 out of 6 crops						
"	0 out of 2 crops				1 out of 2 crops				0 out of 2 crops						
"	0 out of 2 crops				1 out of 2 crops				0 out of 2 crops						
CV % (range)	9.3 - 19.5				2.2 - 6.4				9.7 - 20.0						
Experiment 4	Tc/ha			S% cane			Ts/ha								
	Control	F0.3	F0.45	Mean	Control	F0.3	F0.45	Mean	Control	F0.3	F0.45	Mean			
NC0376	102.4	-	-	102.4	16.0	-	-	16.0	16.3	-	-	16.3			
N25	119.3	-	-	119.3	16.9	-	-	16.9	20.2	-	-	20.2			
Mean	110.8	-	-	110.8	16.4	-	-	16.4	18.3	-	-	18.3			
Significance	2 out of 2 crops				2 out of 2 crops				2 out of 2 crops						
"															
"															
CV % (range)	8.1 - 10.2				3.7 - 3.8				9.1 - 10.7						

Significance indicates the number of crops in which differences were statistically significant (P=0.05)

CV% (range) indicates the range of CV% among crops

Table 4. Average sucrose sampling results for all crops of each experiment at harvest.

Experiment 1 ^a	Sucrose weight (g sucrose/stalk)			Stalk dry weight (g/stalk)			Sucrose % dry matter			
	Control	E+F0.3	E+F0.45	Control	E+F0.3	E+F0.45	Control	E+F0.3	E+F0.45	Mean
NC0376	144.5	136.8	121.8	283.7	247.9	217.3	50.8	55.1	56.2	54.0
N19	178.5	195.8	170.2	321.6	349.4	301.9	55.6	56.0	56.4	56.0
N23	145.0	134.1	130.2	281.9	247.5	235.7	51.4	54.4	55.1	53.6
Mean	156.0	155.6	140.7	295.7	281.6	251.6	52.6	55.2	55.9	54.5
Significance	2 out of 2 crops			2 out of 2 crops			1 out of 2 crops			
"	0 out of 2 crops			2 out of 2 crops			2 out of 2 crops			
"	0 out of 2 crops			1 out of 2 crops			0 out of 2 crops			
CV % (range)	14.0 - 14.1			11.9 - 13.6			4.9 - 5.3			
Experiment 2 ^b	Sucrose weight (g sucrose/stalk)			Stalk dry weight (g/stalk)			Sucrose % dry matter			
	Control	E1.5	F0.45	Control	E1.5	F0.45	Control	E1.5	F0.45	Mean
NC0376	118.0	122.7	123.3	232.0	228.7	229.6	50.9	53.4	53.8	52.6
N23	111.7	114.6	114.5	219.8	220.6	216.8	50.6	51.8	52.8	51.8
N25	137.1	137.4	144.2	263.7	261.1	268.6	51.9	52.2	53.5	52.5
Mean	122.3	124.9	127.3	238.5	236.8	238.3	51.1	52.5	53.4	52.3
Significance	4 out of 4 crops			4 out of 4 crops			1 out of 4 crops			
"	0 out of 4 crops			0 out of 4 crops			2 out of 4 crops			
"	0 out of 4 crops			0 out of 4 crops			0 out of 4 crops			
CV % (range)	14.2 - 21.0			9.5 - 17.5			3.2 - 5.5			
Experiment 3 ^c	Sucrose weight (g sucrose/stalk)			Stalk dry weight (g/stalk)			Sucrose % dry matter			
	Control	E or F0.3	K or F0.45	Control	E or F0.3	K or F0.45	Control	E or F0.3	K or F0.45	Mean
NC0376	163.7	154.2	143.5	304.1	283.3	267.8	54.1	54.5	54.0	54.2
N19	193.7	184.5	183.9	349.8	322.7	334.2	55.5	57.2	55.2	56.0
N25	167.0	167.0	176.7	303.8	295.2	315.0	55.0	56.6	56.1	55.9
Mean	174.8	168.5	168.0	319.2	300.4	305.7	54.9	56.1	55.1	55.3
Significance	1 out of 2			1 out of 2			0 out of 2			
"	0 out of 2			0 out of 2			0 out of 2			
"	0 out of 2			0 out of 2			0 out of 2			
CV % (range)	12.5 - 18.1			12.4 - 13.7			3.4 - 4.6			

Significance indicates the number of crops in which differences were statistically significant (P=0.05)

CV% (range) indicates the range of CV% among crops
a: no data for ratoons 1 and 2

b: plant crop results excluded

c: 4th ratoon results excluded

Table 5. Mean juice purity at the time of ripener application (weeks before harvest in brackets).

Experiment	1R		2R		3R		4R	
	Treatment	Purity (%)	Treatment	Purity (%)	Treatment	Purity (%)	Treatment	Purity (%)
1	E (11)	76.0	E (12)	78.0	E (13)	72.2	E (15)	76.5
	F (8)	77.3	F (7)	81.7	F (9)	83.0	F (10)	84.9
2	E (18)	81.7	E (15)	77.8	E (16)	72.2	E (15)	77.3
	F (11)	87.4	F (10)	81.0	F (11)	78.8	F (10)	83.1
3			E (26) K (26)	80.7	F (5)	90.7		

E = ethephon (weeks before harvest)

F = Fusilade Super (weeks before harvest)

K = Kadostim (weeks before harvest)

Table 6. Mean annualised sucrose yield of varieties as a percentage of NCo376 and N19.

(a) Early season experiments

Experiment	% NCo376			% N19		
	N19	N23	N25	NCo376	N23	N25
1	107	102		93	96	
2		98	107			
mean	107	100	107	93	96	

(b) Mid and late season experiments

Experiment	% NCo376			% N19		
	N19	N23	N25	NCo376	N23	N25
3	106		116	94		110
4			124			
mean	106		120	94		110