

VARIETAL DIFFERENCES IN RATE OF DETERIORATION OF WHOLE STALK SUGARCANE

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Abstract

A trial was conducted to study the rates of deterioration in five sugarcane varieties at three different ages, in cane which was either burnt or unburnt at time of harvest. It was concluded that differences in rates of deterioration can occur in unburnt cane varieties within four to seven days following harvest, and that these increase markedly with time. When the same varieties are harvested immediately after burning, they generally show much smaller differences in deterioration rates. This is probably because the initial rate of sucrose inversion in burnt cane is much less than that in unburnt cane. In unburnt cane varietal differences in rate of juice deterioration are closely associated with rate of sucrose inversion. Over-maturity and/or an extremely hot burn apparently accelerate the rate of cane deterioration, being associated with greater losses in cane weight and increases in reducing sugar content with time than occur in younger cane receiving a moderately hot burn.

Introduction

A number of workers (Barrie,¹ Lauritzen *et al.*,^{4,5} Lingerfelt *et al.*,⁵ Röhrig and Ellis,⁶ Samuels and Cayere,⁷ and Turner⁹) from various sugar producing countries have reported on the considerable differences that exist between sugarcane varieties in their rates of deterioration following harvest. Varieties generally differ most in terms of the loss of recoverable sugar due to rate of inversion of sucrose after cutting, although loss of cane weight and soluble solids through respiration may also be important.

It was decided to investigate varietal differences in rate of deterioration under South African conditions and an unusual opportunity was provided by an existing variety trial, which permitted the simultaneous examination of five varieties at three different ages, in cane which was both burnt and unburnt at time of harvest.

Procedure

Five varieties (N50/211, NCo 382, NCo 376, N51/168 and N53/216) of ratoon cane aged 12, 18 and 24 months were used, the cane being harvested on three successive days in ascending order of age. Samples comprising 280 randomly selected stalks of burnt and/or unburnt cane of each variety for each age group were taken on day 0. Each of these samples was then made into 28 bundles, each consisting of 10 stalks.

No 24-month old unburnt cane was available. The burnt and unburnt plots of both the 12 and the 18-month old cane comprised different ratoons, but soil, climatic conditions during growth, and time of burning and cutting were the same for all plots.

Sampling to determine losses in cane weight, recoverable sugar and the changes in juice quality was carried out on days 0, 2, 4, 7, 11, 15 and 21 following harvest. All cane bundles were weighed on day 0, and all but the samples for immediate analysis were returned to stacks in the field. Selected bundles were subsequently reweighed on the day of sampling in order to determine changes in weight with time. On each day of sampling four bundles of each variety, both burnt and unburnt, were taken from each age group. All determinations were carried out on stripped whole stalks which had been topped by hand in the field.

During the period of the trial (21/11/72 - 14/12/72) a total of 75,0 mm of rain was recorded, of which 15,1 mm, 16,9 mm, 10,5 mm and 9,3 mm fell on days 2, 7, 17 and 20 respectively. Humidity was generally high, the average humidity at 2 p.m. throughout being 93, and values of over 100 were recorded on several days.

A moderately hot burn was achieved in both the 12 and 18-month old cane. The 24-month cane was subject to an extremely hot burn owing to the much larger amount of trash present in this crop.

Results and Discussion

Tables 1A and 1B show data for fibre, brix, purity, sucrose, estimated recoverable sugar (ERS), units of recoverable sugar and weight for each of the five varieties aged 18 and 24 months respectively. Analytical data for the 12-month old cane have been omitted as they were very similar to those obtained for the 18-month old cane.

As was to be expected there were some marked differences in fibre and recoverable sugar among the five varieties, and the burnt cane was seen to dry out more rapidly with time than the unburnt cane, as has been noted previously (Wood *et al.*¹⁰).

Table 2 and Figures 1 and 2 show that rates of deterioration in terms of reduction in recoverable sugar and purity, and increases in reducing sugars, varied far less between varieties when they were burnt at harvest, than they did in those which were left unburnt, particularly during the first week following harvest (see also Table 3). This is not altogether surprising since it has previously been shown (Wood *et al.*¹⁰) that the purity of juice from unburnt cane generally declines more rapidly than does the purity of juice from burnt cane, at least during the week immediately after harvest.

Varietal differences in rates of deterioration are best seen in Figures 1A and 1B, which show the decline in purity of juice from unburnt cane cut at 12 and 18 months of age. From day 7 onwards decline was

Table 1A
Losses due to deterioration following harvest of five varieties of cane — 18 months old
(means of four bundles adjusted for change in weight*)

Day	Fibre %	Brix %	Pur. %	Suc. %	ERS %	Units rec. sugar	Wt. loss %	Fibre %	Brix %	Pur. %	Suc. %	ERS %	Units rec. sugar	Wt. loss %	
			BURNT					N50/211				UNBURNT			
0	15,68	16,60	89,9	14,92	13,22	100	—	16,24	17,58	89,6	15,75	13,94	100	—	
2	14,22	16,24	88,3	14,34	12,53	95	- 2,1	15,21	17,27	85,9	14,82	12,78	92	- 2,6	
4	14,80	16,11	87,3	14,07	12,24	93	- 2,5	14,84	17,33	86,4	14,97	12,97	93	- 3,1	
7	14,38	16,31	85,8	13,98	12,07	91	- 3,8	15,40	16,76	85,9	14,41	12,39	89	- 3,8	
11	14,51	15,34	81,0	12,41	10,17	77	-12,1	15,38	16,42	83,0	13,62	11,39	82	- 8,8	
15	14,41	14,19	75,2	10,66	8,13	61	-18,2	14,93	15,94	78,3	12,48	9,96	71	-12,7	
21	14,92	12,82	72,7	9,31	6,76	51	-20,2	15,49	14,96	74,2	11,09	8,34	60	-14,0	
								NCo 382							
0	16,65	16,34	91,0	14,87	13,21	100	—	16,27	16,44	91,8	15,09	13,50	100	—	
2	16,68	16,02	90,9	14,56	12,90	98	- 1,9	15,64	16,76	86,7	14,08	12,13	90	- 2,4	
4	16,36	15,70	89,3	14,03	12,29	93	- 2,8	16,01	15,71	86,9	13,67	11,76	87	- 3,2	
7	16,11	15,84	87,0	13,77	11,86	90	- 3,5	15,57	15,76	84,8	13,36	11,30	84	- 4,9	
11	15,91	14,14	81,1	11,47	9,26	70	-11,3	16,02	14,93	81,9	12,23	10,01	74	-10,2	
15	15,81	13,55	74,3	10,06	7,47	57	-18,2	15,64	14,27	73,9	10,55	7,86	58	-14,0	
21	16,37	12,10	68,3	8,27	5,47	41	-21,4	15,87	13,87	70,5	9,77	6,89	51	-14,6	
								NCo 376							
0	13,52	17,32	92,3	15,99	14,57	100	—	12,83	17,36	92,2	16,01	14,62	100	—	
2	12,86	16,89	90,2	15,24	13,71	94	- 2,3	12,70	17,14	86,8	14,88	13,05	89	- 2,2	
4	12,94	16,59	89,5	14,85	13,25	91	- 2,2	12,33	16,82	85,3	14,36	12,45	85	- 2,7	
7	12,20	16,90	87,5	14,79	13,07	90	- 3,0	12,27	16,76	83,8	14,04	12,02	82	- 4,1	
11	12,04	14,91	83,8	12,50	10,64	73	-11,5	12,48	16,13	80,5	12,99	10,74	73	-10,5	
15	12,56	14,16	77,9	11,04	8,80	60	-18,5	11,98	15,63	75,5	11,79	9,25	63	-14,6	
21	12,54	13,19	74,4	9,82	7,46	51	-18,6	12,22	14,51	68,7	9,97	7,09	48	-14,1	
								N51/168							
0	13,68	16,96	90,2	15,29	13,70	100	—	13,92	17,09	90,8	15,52	13,97	100	—	
2	13,55	16,46	88,4	14,55	12,85	94	- 1,7	13,74	16,83	88,8	14,94	13,23	95	- 2,0	
4	13,72	16,53	89,5	14,79	13,16	96	- 2,0	13,53	16,14	87,8	14,18	12,45	89	- 2,7	
7	13,36	16,28	86,3	14,04	12,19	89	- 2,6	13,42	16,47	87,9	14,48	12,74	91	- 3,9	
11	13,32	15,04	81,4	12,30	10,11	74	- 8,8	13,67	15,56	81,0	12,61	10,39	74	- 8,9	
15	13,36	14,35	74,0	10,61	8,04	59	-14,3	13,58	14,66	70,9	10,40	7,55	54	-12,5	
21	14,00	12,95	66,2	8,57	5,65	41	-18,1	13,92	13,94	67,5	9,41	6,41	46	-13,2	
								N53/216							
0	16,23	16,86	91,6	15,44	13,83	100	—	15,63	17,10	90,9	15,56	13,89	100	—	
2	15,48	17,29	90,1	15,58	13,86	100	- 2,2	15,32	16,63	87,7	14,59	12,72	92	- 2,7	
4	15,68	16,68	90,2	15,04	13,35	97	- 2,7	15,01	16,72	85,3	14,27	12,22	88	- 3,7	
7	15,43	16,52	86,2	14,24	12,24	89	- 4,0	15,22	16,60	82,2	13,64	11,36	82	- 4,4	
11	15,21	14,47	75,0	10,86	8,23	60	-13,2	14,82	15,96	74,7	11,92	9,12	66	-10,7	
15	15,47	13,63	69,5	9,47	6,58	48	-19,5	15,19	15,26	70,4	10,73	7,67	55	-13,3	
21	15,74	12,25	67,6	7,67	4,54	33	-22,4	15,11	14,35	62,0	8,91	5,41	39	-14,1	

*Figures adjusted for weight loss or gain from that on day 0.

far more rapid in N53/216 than in any other variety, the rate being two or three times that in N50/211 where it was least. Deterioration rates of the three remaining varieties fell between these two extremes. Figures 2A and 2B show that these differences were closely associated with the rate of increase of reducing sugars in juice from the unburnt cane.

The 24-month old burnt cane lost weight faster, and suffered more severe sucrose inversion than did either the 12 or 18-month old burnt cane (see Figures 1 and 2, C-E). Average losses in recoverable sugar

and weight in all varieties of burnt cane for the different age groups are compared in Figures 3A and 3B.

There appear to be two possible causes of the more rapid decline of the 24-month old cane, in which only negligible differences in deterioration rates between varieties were observed. Over-maturity may be responsible as Egan² states that accelerated rates of deterioration can be found in over-mature cane especially in hot weather, or the intensity of the burn may hasten deterioration as reported by Stephenson and Doolan.⁸

TABLE 1B
Losses due to deterioration following harvest of five varieties of burnt cane — 24 months old
 (means of four bundles adjusted for change in weight*)

Day	Fibre %	Brix %	Purity %	Sucrose %	ERS %	Units rec. sugar	Wt. loss %
N50/211							
0	15,51	15,56	87,8	13,67	11,87	100	—
2	14,72	15,79	87,9	13,88	12,11	102	— 0,1
4	14,71	16,87	85,2	14,38	12,35	104	— 5,3
7	14,53	15,55	77,7	12,09	9,59	81	— 7,1
11	14,59	15,45	64,9	10,02	6,55	55	— 14,9
15	15,09	13,78	51,0	7,03	2,90	24	— 23,3
21	15,80	11,88	45,7	5,43	1,40	12	— 30,3
NCo 382							
0	15,70	16,93	90,1	15,25	13,54	100	—
2	15,90	16,21	90,1	14,61	12,93	95	— 0,4
4	15,38	15,72	88,8	13,95	12,21	90	— 5,2
7	14,93	15,54	82,1	12,75	10,55	78	— 8,4
11	15,20	13,97	68,8	9,60	6,61	49	— 15,9
15	15,23	13,01	55,0	7,16	3,46	26	— 24,7
21	16,24	11,63	40,7	4,74	0,47	3	— 30,5
NCo 376							
0	12,71	16,64	87,6	14,58	12,86	100	—
2	12,83	16,82	90,0	15,14	13,59	106	+ 0,1
4	12,14	16,54	88,6	14,65	13,04	101	— 5,0
7	12,11	16,04	82,2	13,18	11,10	86	— 6,1
11	11,45	14,41	71,1	10,23	7,55	59	— 12,1
15	11,81	13,58	57,7	7,84	4,37	34	— 22,3
21	12,51	11,38	48,6	5,53	1,98	15	— 27,5
N51/168							
0	13,93	17,26	91,4	15,78	14,27	100	—
2	13,27	16,62	90,4	15,02	13,49	95	— 0,7
4	13,05	17,00	89,0	15,12	13,46	95	— 5,2
7	12,59	16,87	81,0	13,67	11,39	80	— 8,0
11	13,27	15,00	67,0	10,08	6,94	49	— 16,0
15	12,50	14,75	53,0	7,80	3,71	26	— 21,7
21	13,79	12,63	42,3	5,36	1,20	8	— 27,1
N53/216							
0	14,65	17,40	91,8	15,98	14,46	100	—
2	14,71	17,12	91,5	15,66	14,12	98	— 0,5
4	14,49	16,65	86,6	14,43	12,52	87	— 5,2
7	13,55	16,91	79,6	13,47	11,03	76	— 6,8
11	14,18	15,47	65,9	10,19	6,80	47	— 14,1
15	13,97	14,66	48,0	7,03	2,53	17	— 22,9
21	14,64	12,64	42,0	5,32	0,93	6	— 29,5

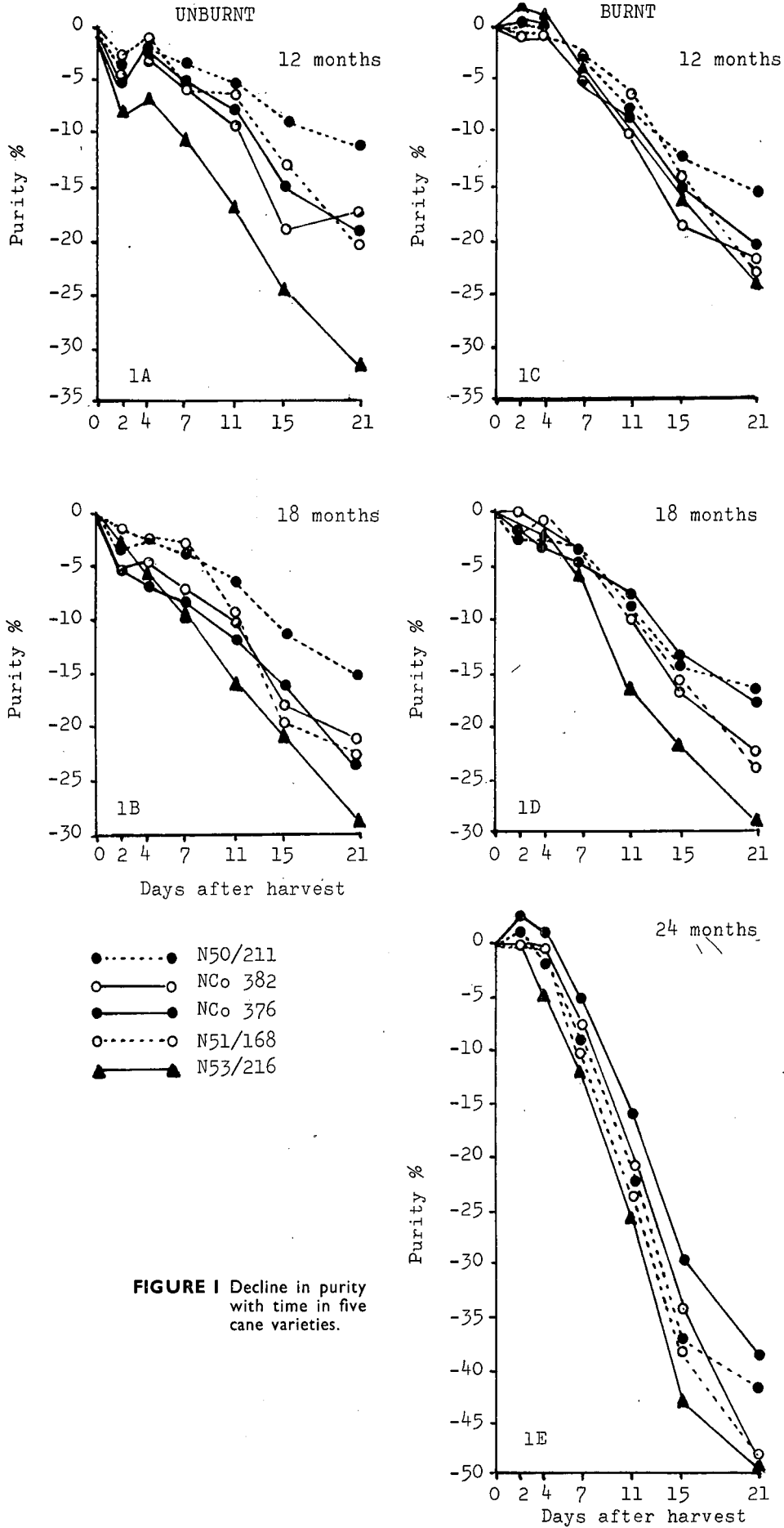
* Figures adjusted for weight loss or gain from that on day 0.

Conclusions

1. Differences in rates of deterioration can occur in unburnt cane of different varieties within four to seven days following harvest, and the differences become progressively greater with time.
2. When the same varieties are burnt prior to harvest, differences in deterioration rates are generally much smaller and occur after a longer period. This is because the rate of sucrose inversion is initially lower in burnt cane than it is in unburnt cane.
3. In unburnt cane varietal differences in rate of juice deterioration are shown to be closely associated with the rate of sucrose inversion.
4. Over-maturity and/or an extremely hot burn apparently accelerate the rate of cane deterioration, being associated with greater losses in cane weight and increases in reducing sugar content with time than occur in younger cane receiving a moderately hot burn.
5. Age of cane at harvest apparently has little or no effect on deterioration rates of different varieties, though over-maturity may have contributed to the rapid decline of all the 24-month old cane.

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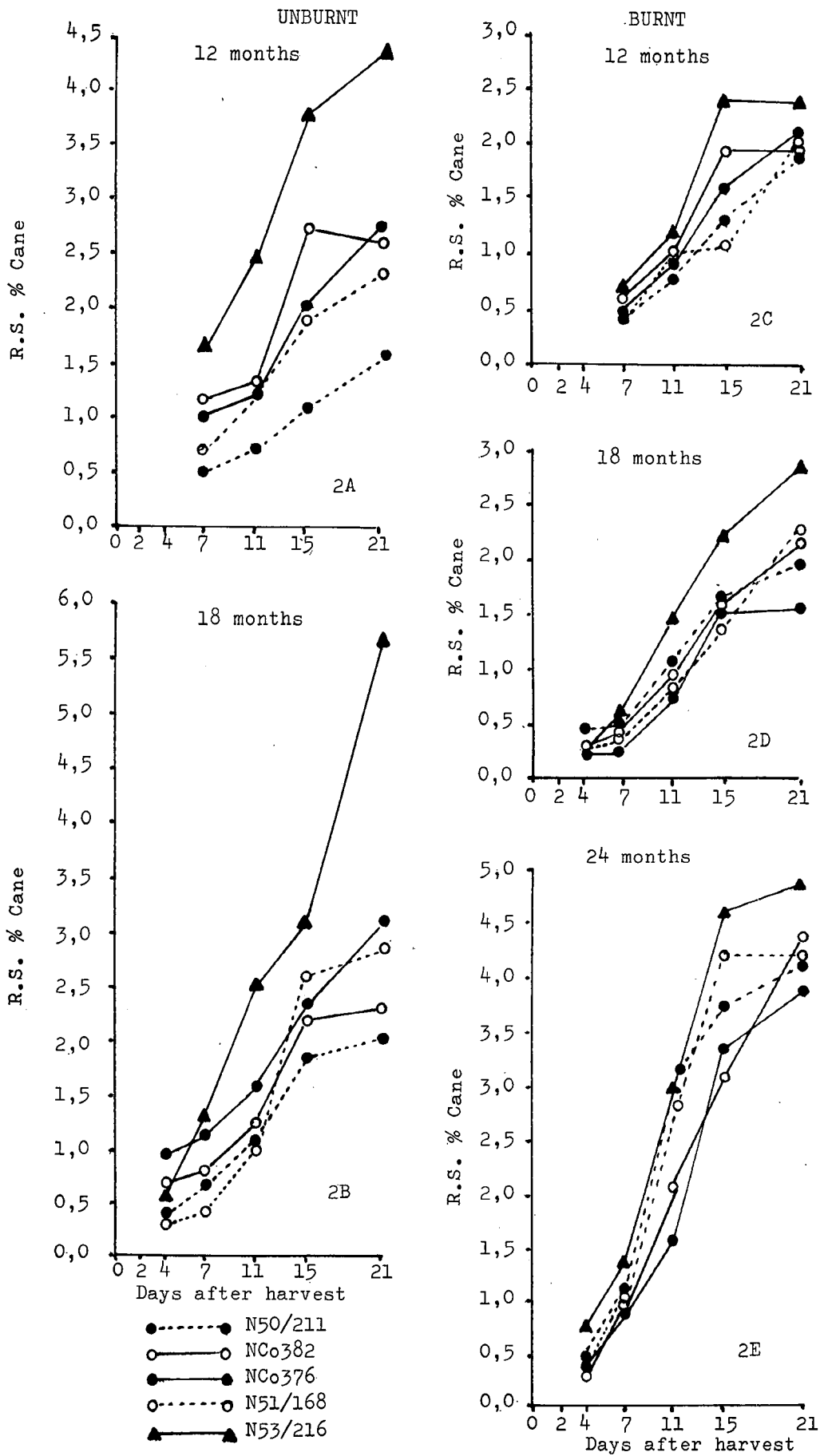


FIGURE 2: Increase in reducing sugars with time in five cane varieties.

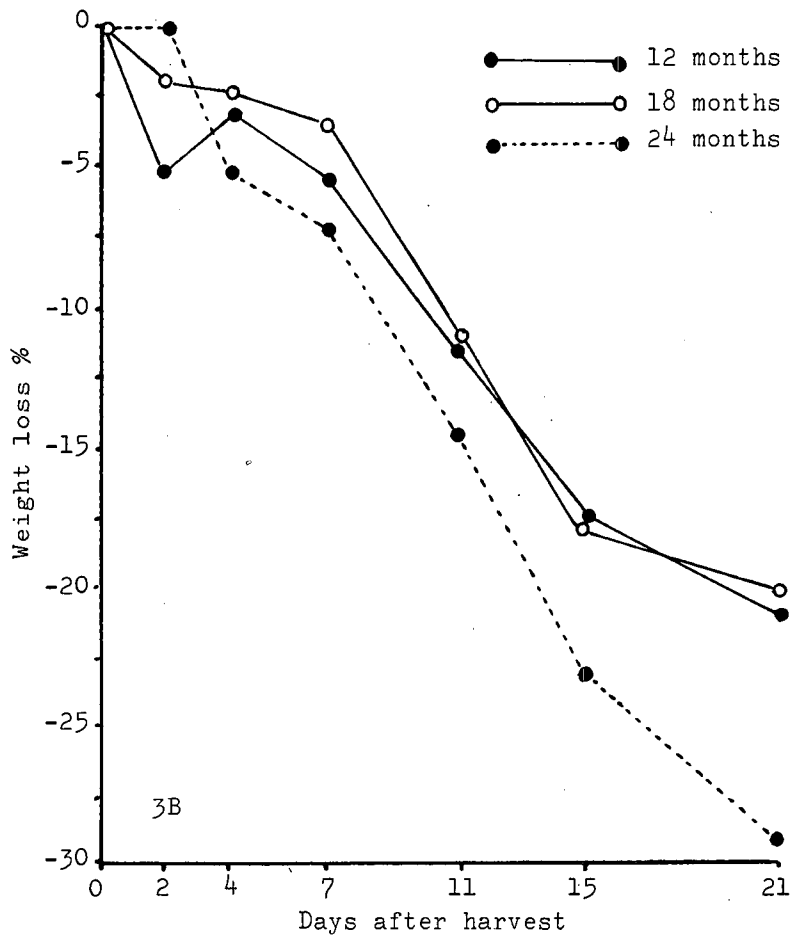
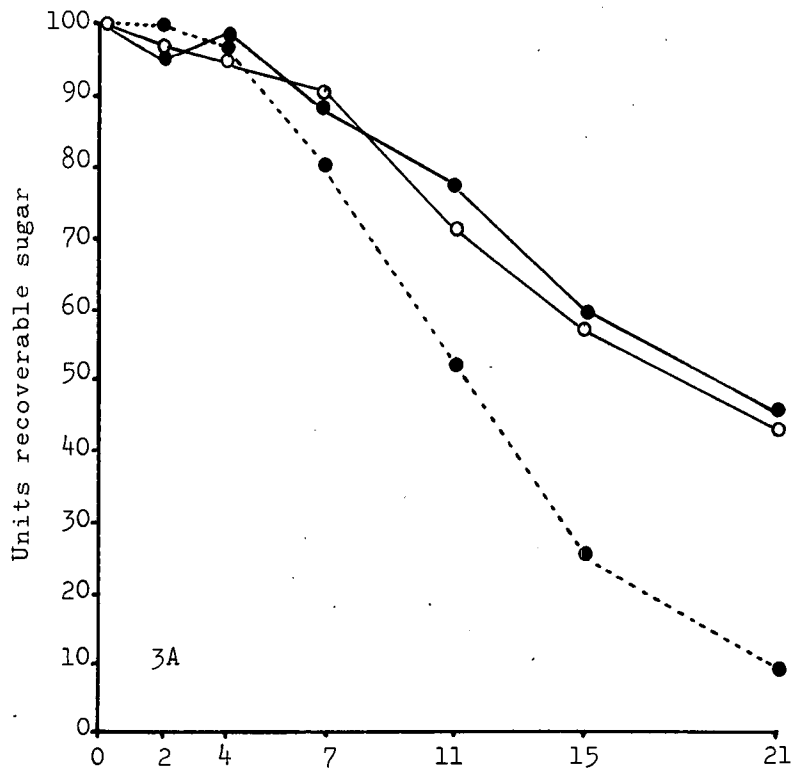


FIGURE 3: Average loss of recoverable sugar and weight for all burnt cane varieties at 12, 18 and 24-months old.

TABLE 2
Changes in ERS % with time following harvest of five varieties of cane of different ages
(figures adjusted for weight loss or gain from that on day 0)

Day	N50/211	NCo 382	NCo 376	N51/168	N53/216	Day	N50/211	NCo 382	NCo 376	N51/168	N53/216
Burnt — 12 months						Unburnt — 12 months					
0	—	—	—	—	—	0	—	—	—	—	—
2	-0,09	-0,91	-0,72	-1,63	+0,15	2	-1,75	-1,11	-2,09	-1,38	-2,28
4	-0,01	+0,25	-0,51	-0,97	+0,11	4	-0,48	-0,20	-0,18	-0,40	-2,08
7	-1,33	-1,58	-1,72	-1,40	-1,54	7	-1,61	-0,89	-2,03	-1,78	-2,72
11	-2,88	-2,77	-3,39	-2,91	-3,05	11	-2,15	-2,48	-2,68	-2,16	-4,84
15	-4,54	-5,67	-5,33	-5,33	-5,57	15	-3,04	-4,80	-4,49	-3,81	-6,66
21	-5,88	-6,74	-7,40	-7,84	-7,88	21	-3,93	-4,94	-6,05	-5,95	-8,54
Burnt — 18 months						Unburnt — 18 months					
0	—	—	—	—	—	0	—	—	—	—	—
2	-0,69	-0,31	-0,86	-0,85	+0,03	2	-1,16	-1,37	-1,57	-0,74	-1,17
4	-0,98	-0,92	-1,32	-0,54	-0,48	4	-0,97	-1,74	-2,17	-1,52	-1,67
7	-1,15	-1,35	-1,50	-1,51	-1,59	7	-1,55	-2,20	-2,60	-1,23	-2,53
11	-3,05	-3,95	-3,93	-3,59	-5,60	11	-2,55	-3,49	-3,88	-3,58	-4,77
15	-5,09	-5,74	-5,77	-5,66	-7,25	15	-3,98	-5,64	-5,37	-6,42	-6,22
21	-6,46	-7,74	-7,11	-8,05	-9,29	21	-5,60	-6,61	-7,53	-7,56	-8,48
Burnt — 24 months											
0	—	—	—	—	—						
2	+0,24	-0,61	+0,73	-0,78	-0,34						
4	+0,48	-1,33	+0,18	-0,81	-1,94						
7	-2,28	-2,99	-1,76	-2,88	-3,43						
11	-5,32	-6,93	-5,31	-7,33	-7,66						
15	-8,97	-10,08	-8,49	-10,56	-11,93						
21	-10,47	-13,07	-10,88	-13,07	-13,53						

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TABLE 3

Range of decline in ERS and purity, and amounts of reducing sugars in five burnt and unburnt cane varieties one week after harvest

Treatment	ERS	Purity	Reducing sugars
Burnt	-1,33 to -1,72%	-2,7 to -4,9%	0,42 to 0,70%
Unburnt (12 months)	-0,89 to -2,72%	-3,9 to -10,7%	0,52 to 1,64%
Burnt	-1,15 to -1,59%	-3,9 to -5,4%	0,23 to 0,60%
Unburnt (18 months)	-1,23 to -2,60%	-2,9 to -8,7%	0,38 to 1,30%