

EFFECTS OF AGE AND HARVEST SEASON ON THE YIELD AND QUALITY OF SUGARCANE

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Abstract

An experiment was established in which two varieties (NCo 310 and NCo 376) were harvested at four times during the season (May, July, September and November). At each time of harvest several ages of crop (chosen from 10, 12, 14, 16 and 18 months) were compared. Results were obtained from 1st, 2nd and 3rd ratoon crops.

Time of harvest had a considerable influence on yield and quality of cane. The best yields of sugar/ha were obtained in July and September; yields in May were low because of poor cane quality while November yields were low because of low cane yields. Fluctuations in cane yields were due to variations in both moisture content and dry matter accumulation.

Highest yields of tons sucrose/ha month for NCo 310 were obtained at 10 months of age except in November when the optimum age was 14 months. The optimum age for NCo 376 was 12 months between July and November, but in May it was 10 months. The results indicate that the practice of retaining standover cane for the early season should be avoided under good growing conditions. Indeed, it appears that cane harvested in May should be younger than 12 months, while in November, the optimum age is nearer 14 months.

Introduction

In Rhodesia sugarcane crops are usually harvested at about 12 months of age, but it is generally considered that the optimum age of harvest varies with time of harvest. Thus it is frequently believed to be desirable to harvest 14-16 month old cane during April-May and 12 month old cane during the remainder of the season. Further information was also required regarding the best time of year to harvest the two major varieties, NCo 310 and NCo 376. This study was consequently initiated to obtain data on the effect of age of harvest on the yield and quality of NCo 310 and NCo 376 at different times during the harvesting season.

TABLE 1
Ages and Dates of Harvest

Harvest Dates	Age (Month)				
	10	12	14	16	18
May 1972	July 71	May 71	—	—	Nov 70
Jul 1972	Sep 71	Jul 71	May 71	—	—
Sep 1972	Nov 71	Sep 71	Jul 71	May 71	—
Nov 1972	—	Nov 71	Sep 71	Jul 71	May 71
May 1973	Jul 72	May 72	—	—	Nov 71
Jul 1973	Sep 72	Jul 72	May 72	—	—
Sep 1973	Nov 72	Sep 72	Jul 72	May 72	—
Nov 1973	—	Nov 72	Sep 72	—	—
May 1974	Jul 73	May 73	—	—	Nov 72
Jul 1974	Sep 73	Jul 73	May 73	—	—
Sep 1974	—	Sep 73	Jul 73	—	—
Nov 1974	—	—	Sep 73	—	May 73

Dates in the body of the table are ratooning dates which were used to achieve the ages and dates of harvest given in the margins.

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Methods

In August 1970 an experiment was planted under furrow irrigation on the Rhodesia Sugar Association Experiment Station farm to study the effect of harvest age and time of season on cane yield and quality. Between November 1970 and November 1971 the plant crop was ratooned in order to bring the experiment into cycle; yields were not measured. A total of 3 ratoons were harvested between 1972 and 1974 and details of treatments are given in Table 1. Because of the complexities of designing a trial of this nature, it was not possible to have all combinations of treatments in each ratoon.

There were 3 replications of 15 whole plots, each split for 2 varieties, NCo 376 and NCo 310, sub-plots being 13m×9m gross and 10m×6m net. Whole plots were randomised for harvest dates. In plant cane, 150 kg of N/ha were applied as ammonium nitrate and 160 kg P₂O₅/ha were applied as single superphosphate. In ratoons 180 kg N/ha and 80 kg P₂O₅/ha were applied. Differential irrigation of treatments was not possible because of the layout. No drying off was imposed. At each harvest the weight of cane was recorded and 24 canes were subjected to direct cane analysis after preparation in the Jeffco cutter-grinder and Alfa Laval cold extractor. Estimated recoverable sugar % cane was calculated as follows:—

$$\text{ERS}\%C = \text{Sucrose} - 0,451 (\text{Brix-Sucrose}) - 0,077 \text{ Fibre}$$

Results

(1) Effect of Season

(a) Cane Yield

In order to obtain the most useful information on the effect of time at which the cane was harvested during the season, comparisons have been made for 12 month old crops only in this section, i.e. in Table 2 and Figs. 1, 2 and 3.

TABLE 2
Effect of season on 12 month old cane
(Mean of 1st, 2nd and 3rd ratoons of NCo 310 and NCo 376.)

	Harvest Dates			
	May	July	September	November*
Tons cane/ha	150,1	151,8	137,1	125,2
Sucrose % cane	12,2	15,1	15,8	15,3
Tons sucrose/ha	18,3	22,9	21,7	19,2
Fibre % cane§	10,1	11,8	13,8	13,3
Moisture % cane	74,0	71,4	68,8	69,7
Tons dm/ha	39,0	43,4	42,8	37,9
Stalk population (000's/ha)*	140,3	143,4	141,4	132,6
Stalk diameter (mm)†	24,7	24,2	23,6	22,1
Lodging‡	73	66	63	53

* Yield data from 3rd ratoon missing; values calculated by missing plot technique (reps=ratoons).

† 1st ratoon only.

‡ 1st and 3rd ratoons only.

§ 2nd and 3rd ratoons only.

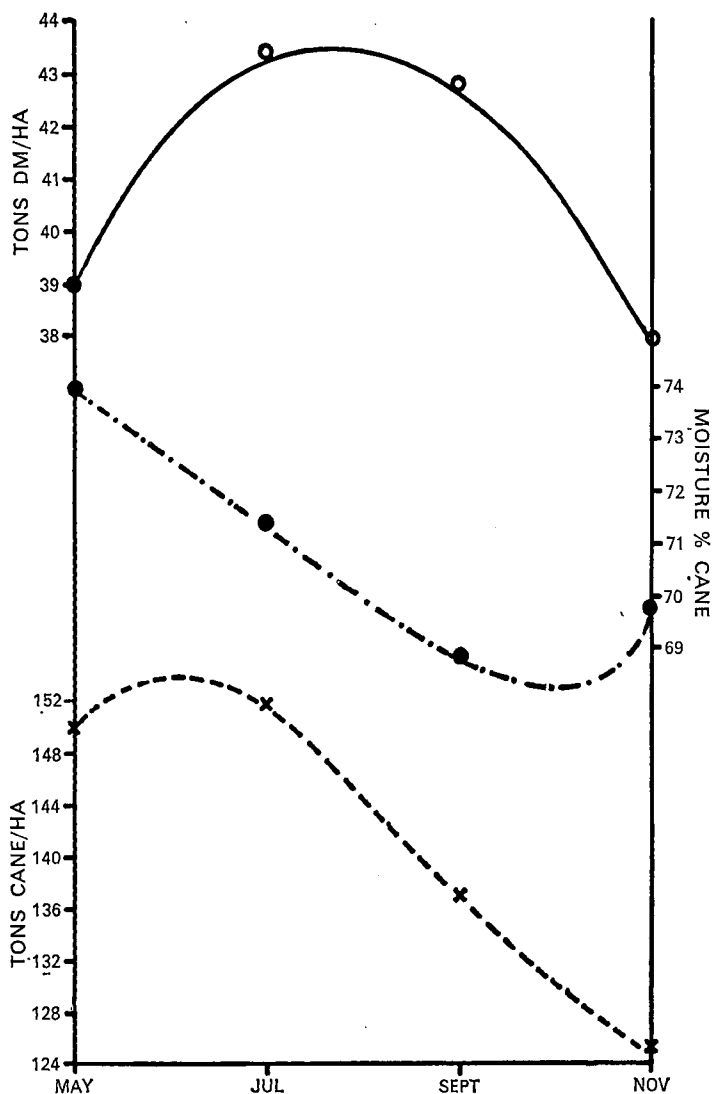


FIGURE 1 Effect of time of season on dry matter, moisture and cane yield (mean NCo 310 and NCo 376) — 12 months harvest.

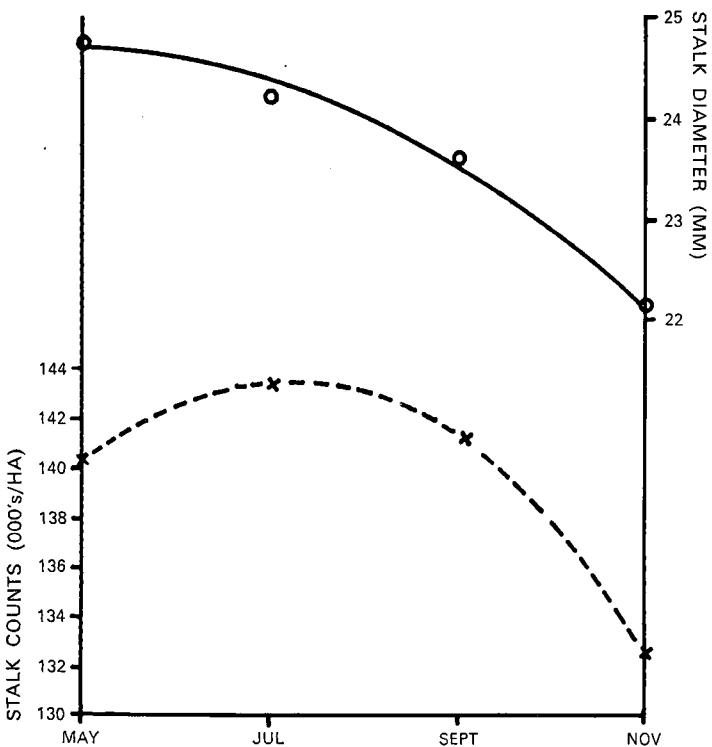


FIGURE 2 Effect of season on stalk characteristics (Mean NCo 310 and NCo 376 — 12 months harvest.)

Cane yields were very similar when 12 month old cane was harvested in May and July. However, yields dropped markedly with late season harvesting. These variations in cane yield during the season are partly due to changes in moisture % cane and partly due to changes in dry matter accumulation, as shown in Fig. 1. There was a marked rise in dry matter accumulation between May and July which was counterbalanced by a marked reduction in moisture % cane, to give approximately equal tons cane/ha. There was a further drop in moisture % cane between July and September which accounted for the drop in cane yield since dry matter production was similar for these two times of harvest. The marked drop in cane yield between September and November was entirely due to lower dry matter accumulation in November since the moisture % cane rose very slightly between September and November. It should be noted again here that all crops described were 12 months old at harvest in the month mentioned.

Changes in both stalk populations and stalk diameters were associated with the fluctuations in cane yields. Stalk population rose slightly from May to July and then fell towards the end of the season, while stalk diameters decreased throughout the season. In both cases there was a marked drop between September and November as shown in Figure 2.

(b) Cane Quality and Sucrose Yield

There was a marked rise in sucrose % cane between May and July; there was relatively little difference between July and November with a peak in September, as shown in Figure 3,

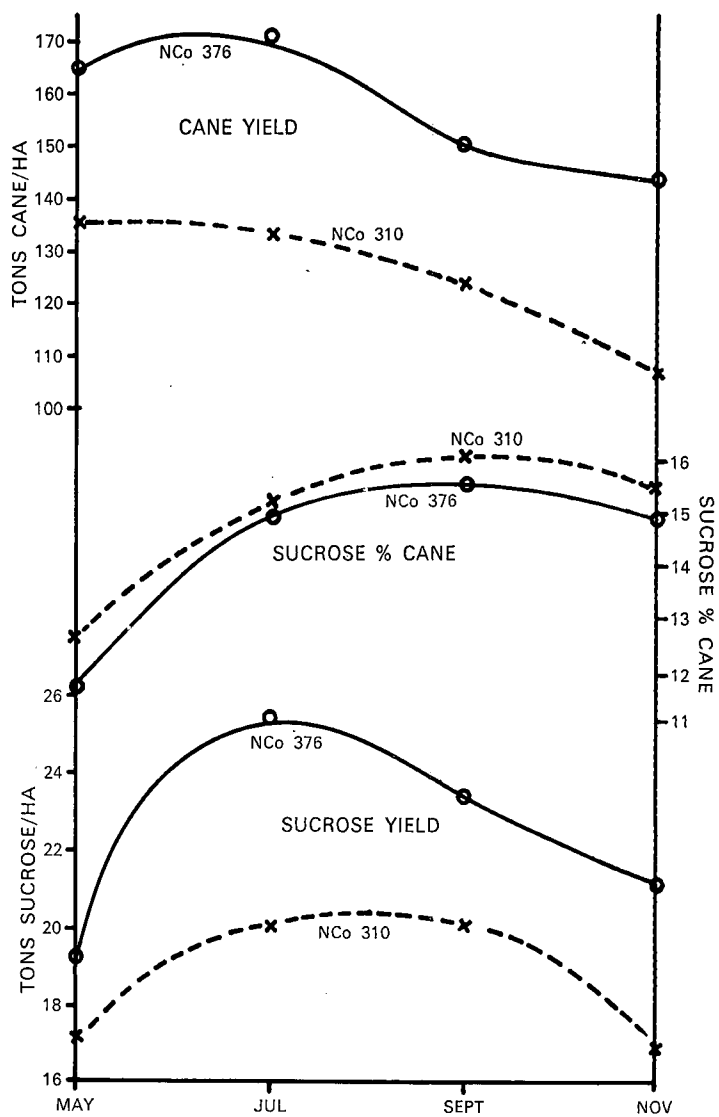


FIGURE 3 Effect of season on sucrose content and yields of varieties NCo 310 and NCo 376.

this had the result of producing the highest sucrose yields in July, with September also high, but both May and November were appreciably lower.

Fibre % cane increased steadily up to September, but dropped slightly in November. This was a surprising result as a continuing rise to November would be expected; which in fact did occur during the 3rd ratoon.

(2) *Effect of Age*

(a) *May crop (Table 3)*

The bulk of the cane is apparently produced by the time that the crop is 10 months old with a May harvest, and cane yield per hectare month declined markedly with older crops.

TABLE 3
Effect of age on May crop
(Mean of 1-3 ratoons and NCo 310/NCo 376.)

	Age (Months)		
	10	12	18
Tons cane/ha	144,5	150,1	200,0
Tons sucrose/ha	16,91	18,25	22,01
Tons cane/ha month	14,57	12,58	11,36
Sucrose % cane	11,8	12,2	10,8
Tons sucrose/ha month	1,72	1,53	1,23
Fibre % cane†	9,85	10,10	11,15
% Purity	77,9	78,7	81,1
Moisture % cane	74,8	74,0	75,6
Tons dm/ha month	3,66	3,28	2,75
Diameter (mm)*	23,6	24,7	22,3
% Lodging†	61	73	95

* 1st ratoon only.
† Mean 1st and 3rd ratoon.
‡ Mean 2nd and 3rd ratoons.

Sucrose % cane rose between 10 and 12 months of age, but dropped sharply in 18 months old cane. This was consistent over all three ratoons and both varieties, and indicates that well grown cane under favourable conditions should not be carried over, as the expected improvement in quality does not materialise. The lower sucrose content of 18 month old cane must be due to its heavy lodging, which has been found to reduce sucrose % cane by up to 1,8% (Anon.¹). These results contrast with those of Rostron³ who found that sugar content tended to increase with increasing age.

The yield of sucrose/ha month was also highest at 10 months of age but dropped rapidly thereafter. Fibre % cane increased with age and was considerably higher in the 18 month old crop. Purity on the other hand increased with age. Moisture % cane was slightly lower in the 12 month old crop but increased again in the 18 month old crop, presumably as a result of bull shoot development. As with cane yield, dry matter production per month was considerably reduced after 10 months of age.

Diameter of stalks increased up to 12 months of age and appeared to decline thereafter to 18 months of age. However, this may be related to the month of ratooning (q.v.). Lodging increased with age.

(b) *July crop (Table 4)*

The optimum age for cane production was again 10 months, with the tons cane/ha month being slightly lower for 12 months and much lower for 14 months than for 10 months of age. However, there was a rise in sucrose % cane between 10 and 12 months of age; thus the tons sucrose/ha month were almost identical for 10 and 12 month old crops with 14 month old cane being appreciably poorer.

Fibre % cane, purity and lodging all increased steadily between 10 and 14 months of age with a July harvest, while moisture % cane decreased with increasing age.

TABLE 4
Effect of age on July crop
(Mean of 1-3 ratoons and NCo 310 and NCo 376.)

	Age (Months)		
	10	12	14
Tons cane/ha	132,1	151,8	157,6
Tons sucrose/ha	18,64	22,86	23,48
Tons cane/ha month	13,42	12,57	11,11
Sucrose % cane	14,2	15,1	15,0
Tons sucrose/ha month	1,91	1,89	1,67
Fibre % cane†	11,55	11,85	12,30
% Purity	86,3	86,9	87,0
Moisture % cane	72,5	71,4	71,2
Tons dm/ha month	3,69	3,60	3,20
Diameter (mm)*	24,4	24,2	24,4
% Lodging†	58	66	71

* 1st ratoon only.
† 1st and 3rd ratoons only.
‡ 2nd and 3rd ratoons only.

(c) *September crop (Table 5)*

There was relatively little difference in the rate of cane production between crops that were 10 and 12 months old; the tons cane/ha month were much lower with crops harvested when 14 and 16 months old. As there was a marked rise in sucrose % cane between crops that were 10 and 12 months old, there was actually an increase in tons sucrose/ha month from 10 to 12 months. Both 14 and 16 month old crops showed a sharp drop in tons sucrose/ha month.

Lodging showed a marked increase with increasing age above 10 months; other parameters did not show consistent trends.

TABLE 5
Effect of age on September crop
(Mean of 1-2 ratoons and NCo 310 and NCo 376.)

	Age (Months)			
	10	12	14	16
Tons cane/ha	126,6	144,8	160,2	163,2
Tons sucrose/ha	19,68	23,95	25,21	27,69
Tons cane/ha month	12,18	12,04	11,29	10,04
Sucrose % cane	15,6	16,5	15,8	17,0
Tons sucrose/ha month	1,90	1,99	1,78	1,71
Fibre % cane	11,6	12,0	12,4	11,2
% Purity	85,6	86,7	86,6	84,6
Moisture % cane	70,0	68,9	70,0	68,6
Tons dm/ha month	3,65	3,74	3,39	3,15
Diameter (mm)*	23,5	23,6	23,8	23,9
% Lodging*	0	64	85	80

* 1st ratoon only.

(d) *November crop (Table 6)*

(No 10 month treatment was included for November harvest since this would mean ratooning in January which is not part of the normal harvesting season). The tons cane/ha month increased for crops from 12 to 14 months old; it decreased with older crops, but the rate of decrease was slower than with harvesting in the early part of the season. There was relatively little difference in sucrose % cane between 12 and 18 month old cane. Consequently, whilst the highest tons sucrose/ha

month was obtained with 14 month old cane, there was little difference with 12 and 16 month old cane and even 18 month old cane was only slightly poorer.

There were few differences in the other parameters between the ages compared.

TABLE 6
Effect of age on November crop
(1st ratoon mean of NCo 310 and NCo 376.)

	Age (Months)			
	12	14	16	17
Tons cane/ha	122,9	147,2	152,6	166,8
Tons sucrose/ha	19,26	22,76	24,71	26,55
Tons cane/ha month	10,07	10,74	9,66	9,32
Sucrose % cane	15,7	15,5	16,2	15,9
Tons sucrose/ha month	1,58	1,66	1,56	1,48
Moisture % cane	69,1	69,2	68,9	68,8
Tons dm/ha month	3,11	3,31	3,00	2,91
Diameter (mm)	22,1	22,4	22,8	23,1
% Lodging	92	98	95	83

(3) Varieties

There appeared to be certain differences between the varieties NCo 376 and NCo 310 in their response to the various factors discussed above. Table 7 shows the results for the two varieties separately.

In May, the optimum age for both varieties was 10 months. In July and September, the optimum age for NCo 376 was 12 months, while that for NCo 310 was 10 months. In November, the optimum age for NCo 376 was again 12 months, but that for NCo 310 was 14 months.

TABLE 7
Effect of age of NCo 310 and NCo 376 on the yield of sucrose/hectare month

	Age (Months)				
	10	12	14	16	18
<i>NCo 376</i>					
May	1,86	1,61	—	—	1,27
July	1,99	2,10	1,80	—	—
September*	1,91	2,10	1,80	1,86	—
November†	—	1,77	1,78	1,73	1,69
<i>NCo 310</i>					
May	1,56	1,44	—	—	1,15
July	1,80	1,68	1,50	—	—
September*	1,87	1,86	1,74	1,56	—
November†	—	1,38	1,54	1,39	1,27

* Mean of 1-2 ratoon.

† First ratoon.

Although seasonal fluctuations in cane yield and sucrose % cane were similar for the two varieties, the rise in yield between May and July, and the decline to September was not as marked in the case of NCo 310 as with NCo 376 (Figure 3). Thus while NCo 310 yielded consistently lower than NCo 376, it compared most favourably in May and to a lesser extent in September; and it appears that NCo 310 should be harvested early in the season or possibly in September. This varies slightly from the findings of Gosnell and Koenig² who found that NCo 310 competed best with NCo 376 in September.

(4) Time of Ratooning

The data from the experiment were tabulated according to the month of ratooning as well as by the month of harvest. Although this gave a rather different slant to the data, conclusions were similar, and it was thought more useful to present the data by the month of harvest. In the case of stalk diameter however, it may be worth presenting the data by the starting date of ratoons; this is given in Table 8.

TABLE 8
Effect of age on stalk diameter (mm)
(1st ratoon mean of NCo 310 and NCo 376)

Month of Ratooning	Age (Months)				
	10	12	14	16	18
May	—	24,7	24,4	23,9	23,1
July	23,6	24,2	23,8	22,8	—
September	24,6	23,6	22,4	—	—
November	23,5	22,1	—	—	—

It can be seen that in all cases (except July, 10 to 12 months) the average stalk diameter declined with increasing age, in several instances by appreciable amounts. This effect is probably mainly due to declining moisture % cane with increasing age but it could also be related to increased lodging with older cane.

Discussion

Effect of Season

The results show that for 12 month old crops in all cases, sucrose yields per hectare were highest in July, closely followed by September. Yields were lowest in May, due to low sucrose % cane, and were also low in November, due mainly to low cane yields.

The variations in cane yield during the season, as shown in Figure 1 were partly due to moisture content and partly to dry matter accumulation. Moisture % cane dropped steadily from May to September, but rose slightly in November. Yields of dry matter, however, peaked in July and September, falling markedly in November. Rostron's³ results showed very similar seasonal fluctuations in yields of cane and dry matter, and in quality of cane. The reduced cane yield with November harvest was associated with smaller diameters and lower stalk counts in November.

Effect of age

When comparing the effect of age on yield per unit time, some very interesting trends emerge. With tons cane/ha month, the optimum age was 10 months in May, 10 in July, either 10 or 12 in September and 14 in November. This is shown in the data below:—

	Age (Months)				
	10	12	14	16	18
May	14,6	12,6	—	—	11,4
July	13,4	12,6	11,1	—	—
September	12,2	12,0	11,3	10,0	—
November	—	10,1	10,7	9,7	9,3

This trend is even more clearly shown in Figure 4, which shows that the optimum age for sucrose accumulation was 10 months in May, 10 or 12 months in July, 12 months in September and 14 months in November.

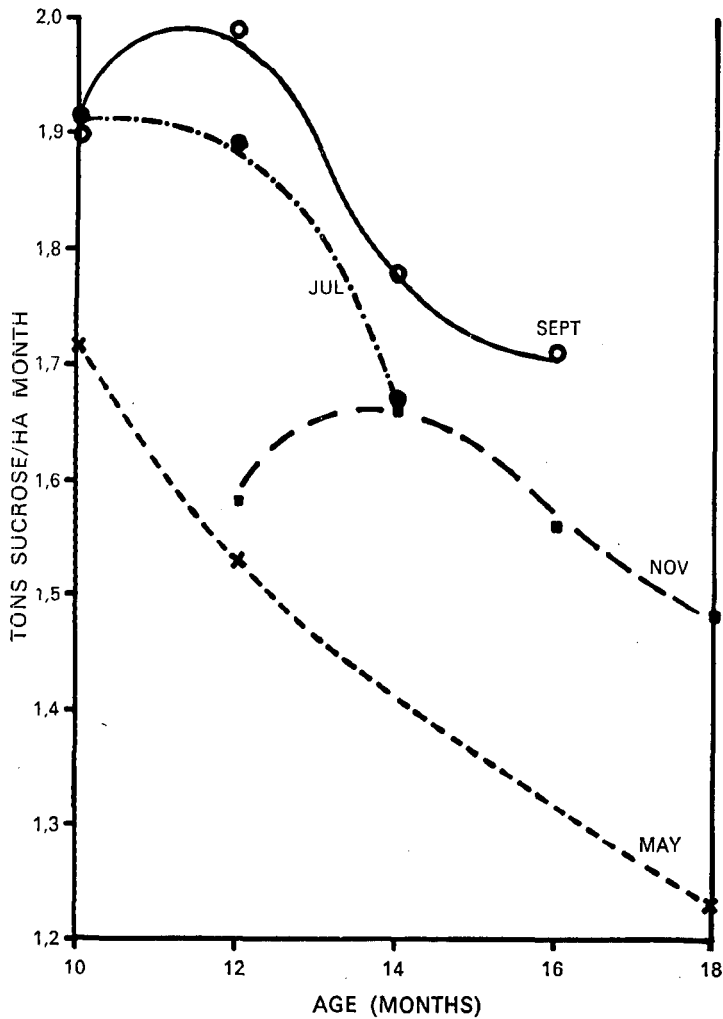


FIGURE 4 Effect of age on tons sucrose/ha month compared at different seasons.

This trend runs across current thinking in the industry, which, as already mentioned, regards May as the month in which it is desirable to harvest the oldest cane. Replanting programmes are frequently carried out in January and February, giving a 14-16 month old plant crop in the early part of the season. Standover ratoon cane gives essentially the same result.

Results from this trial indicate however, that under good growing conditions at least, it is not advisable to stand over cane in the Rhodesian Lowveld. A replanting programme during August - September will permit 13 - 14 month old cane to be harvested towards the end of the season; subsequent ratoon harvests of slightly less than 12 months of age will bring these fields forward year by year in order to achieve optimum tons sucrose per hectare month in the early part of the season at 10 - 12 months of age.

When considering NCo 376 and NCo 310 separately, it appears that the above trends apply much more strongly to NCo 310 than to NCo 376. Nevertheless, as shown in Table 7, it is clear that the optimum age for NCo 376 was 10 months for a May harvest and 12 months for the other times of harvest.

Acknowledgements

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