SOME EFFECTS OF VARIETIES ON SEASONAL FLUCTUATION IN CANE QUALITY

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Abstract

Seasonal fluctuations in cane quality on two Rhodesian sugar estates and in experiments have shown the following: NCo 310 had its main advantage over NCo 376 in sucrose, purity and tons sucrose per hectare in the middle of the season, and it should be cut at this time (August-October). CP 29-116 had a poorer sucrose and purity than NCo 376 throughout the season but the difference was smallest from October to January, and it should therefore be cut at this time. Co 462 was generally similar to NCo 376, but had an advantage at the end of the season. NCo 376, the major variety, had a fairly flat sucrose curve and could thus be cut at any time of season. Fibre % cane peaked in December and was lowest in June; it showed a significant correlation with temperature and radiation.

Introduction

While cane varieties are frequently designated as early, mid- or late season in regard to their ripening characteristics, there is a dearth of factual evidence for the selection of these criteria. In the Dominican Republic, Lingerfelt et al[3] recommended a schedule for cutting varieties at different times of the season based on quantitative estimates of total sugar production over a season using various alternative systems. The highest total sugar production was obtained from harvesting the varieties with the lowest or the most variable sucrose contents during the peak sucrose periods.

In Rhodesia, the usual approach to harvesting has been to keep the highest sucrose content variety (NCo 310) for the months with the lowest sucrose content (April-June and November-January) whilst harvesting NCo 376, the main variety during the remainder of the season. This represents an attempt to minimize large fluctuations in sucrose content of cane arriving at the mill. The third major variety, CP 29-116, has been harvested at all times of the seasons, while Co 462 has mainly been harvested in May-June.

Data have been collected for different varieties over the past six years from two mills (Triangle and Hippo Valley Estates) and from experiments at the R.S.A. Experiment Station, in order to obtain information on the optimum months for harvesting our main varieties.

Methods

Because the two estates have different cane payment systems, the percentage of cane tested and the methods of analysis at the two mills differ substantially. However, they have a few points in common, one of which is to relate the sucrose content of the tested cane to the total delivered and thus establish a sucrose balance. Thus the sucrose % cane figures quoted are corrected figures. Both estates sample the juice of the cane being tested at the 1st mill. In addition, at Hippo Valley, the fibre content of cane is also determined whilst at Triangle the Java Ratio is used to obtain the sucrose % cane.

At Hippo Valley cane from every field of each Section is sampled and analysed at least once and often more than once, depending on the size of the field. Data are thus available from individual fields and therefore comparison of varieties at all times of the milling season is possible. At Triangle a large number of tests are also carried out on each section's cane and as at Hippo Valley, data for brix and purity of 1st expressed juice and sucrose % cane are recorded for each field and variety.

The data from the estates suffer from the disadvantage that variation in age of cane or management techniques might be confounded with real varietal differences. However, the mean values presented refer to thousands of analyses, so that these variables should in general have been ironed out.

In addition to the data from the estates we obtained useful information from Experiment No. 1 in which plots of the four major varieties NCo 310, NCo 376, CP 29-116 and Co 462) were planted at monthly intervals for 18 successive months. The cane was sampled when it reached 9 months of age, and thereafter at monthly intervals until it was 27 months old, for sucrose, brix and fibre % cane by direct analysis using a Jeffco cutter grinder and Alfa-laval cold extractors (Anon [1]). The cane was then cut back and the process was repeated in a succeeding ratoon crop.

This experiment yielded seasonal comparisons for all months of the year for cane at a constant age and under constant management, and thus avoided possible errors that might occur in field data from the mills. However, the number of replications was small, each point on the graphs representing only 11 analyses for each variety.

Data are also available for some of the newer pre-release varieties from 37 crops in 13 variety trials harvested at various times during the season.

Sucrose content

Estate data

Figure 1 shows the mean sucrose contents of the four major varieties for the four year period 1968-1971, averaged for the mills at Triangle and Hippo Valley Estates.

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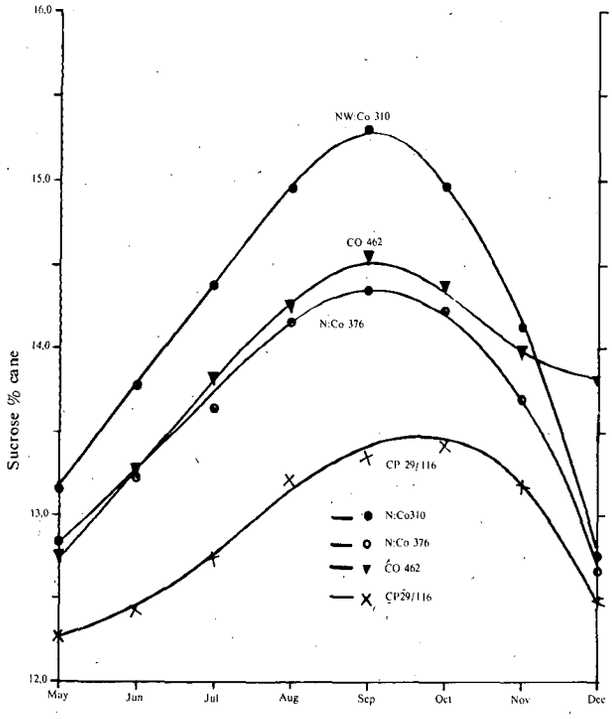


1. Average sucrose % cane data from Hippo Valley and Triangle, 1968—1971.

It can be seen that there were relatively small differences in sucrose content between varieties at the end of the season (November-December) whilst the differences were greatest at the period of peak sucrose (September), and were intermediate at the beginning of the season. It can be inferred that CP 29-116 should only be harvested towards the end of the season, as its peak was later (October) than that of the other varieties and its disadvantage of low sucrose content was least during November-December. NCo 310 had its main advantage over NCo 376 during midseason (August-October) and consequently it should be harvested during this period, and definitely not at the end of the season when it had practically no advantage over NCo 376. Co 462 showed a similar pattern to NCo 376 through most of the season, but gave a higher sucrose content at the end. Its optimum harvest period thus appeared to be November-December. However, it should be noted that the data for Co 462 refer only to 1970 and 1971 and to a substantially lower tonnage than the other varieties.

It is fortunate that the main variety NCo 376 displayed a relatively flat curve and may thus be harvested at any time of the season, as indeed it has to be, since it comprises the bulk of the crop.

Seasonal sucrose contents for the individual years showed very similar trends to the means and the data are given in Table 1.

TABLE I

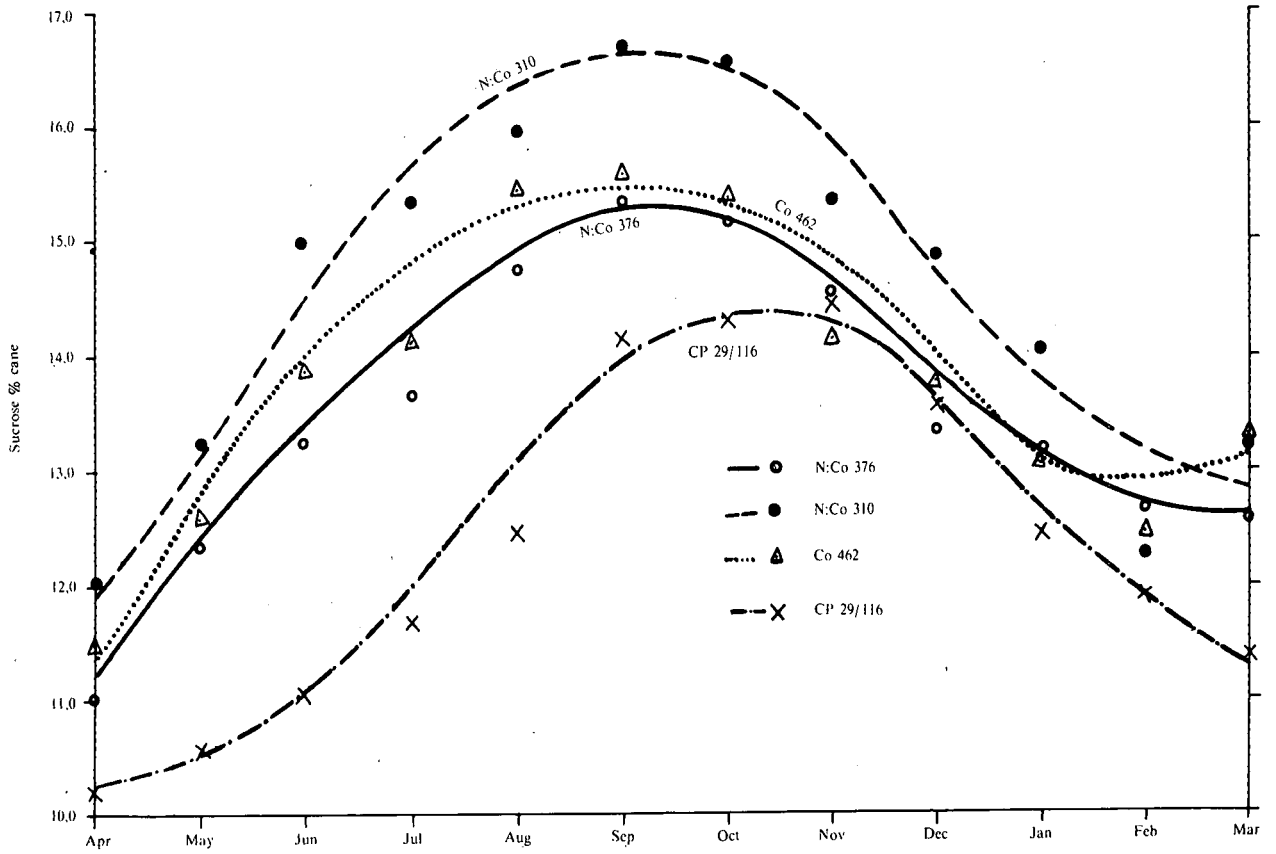
Mean Sucrose % Cane for four varieties at Triangle and Hippo Valley

MONTH	1968	1969	1970	1971	MEAN
			NCo 310		
May		13,11	13,36	12,95	13,14
Jun	13,76	13,35	14,10	14,09	13,82
Jul	14,18	13,97	14,92	14,51	14,40
Aug	14,84	14,64	15,20	15,24	14,98
Sep	15,12	15,02	15,51	15,83	15,37
Oct	14,89	14,34	15,36	15,62	15,05
Nov	14,10	13,43	14,50	14,87	14,22
Dec	10,93	12,36	14,06	14,68	13,01
Jan	10,77				
			NCo 376		
May		11,85	13,03	13,12	12,67
Jun	13,80	12,34	13,12	13,66	13,23
Jul	13,81	12,77	13,84	14,12	13,64
Aug	14,12	13,67	14,42	14,40	14,15
Sep	14,04	14,12	14,60	14,60	14,34
Oct	14,00	13,66	14,65	14,62	14,23
Nov	13,04	13,28	14,34	14,12	13,70
Dec	10,94	12,42	13,67	13,58	12,65
Jan	10,54				
			CP 29—116		
May			12,14	12,37	12,26
Jun	13,36	11,85	12,32	12,18	12,43
Jul	13,44	12,40	13,00	12,10	12,74
Aug	13,56	13,10	13,63	12,60	13,22
Sep	13,09	13,55	14,03	12,77	13,36
Oct	13,35	13,20	13,81	13,32	13,42
Nov	13,35	12,70	13,58	13,06	13,17
Dec	12,14	11,40	13,16	13,14	12,46
Jan	10,68				
			Co 462		
May			13,22	12,23	12,72
Jun			13,36	13,12	13,24
Jul			13,74	13,84	13,79
Aug			14,32	14,11	14,22
Sep			14,74	14,28	14,51
Oct			14,25	14,52	14,38
Nov			13,50	14,83	14,16
Dec			13,70	14,14	13,92

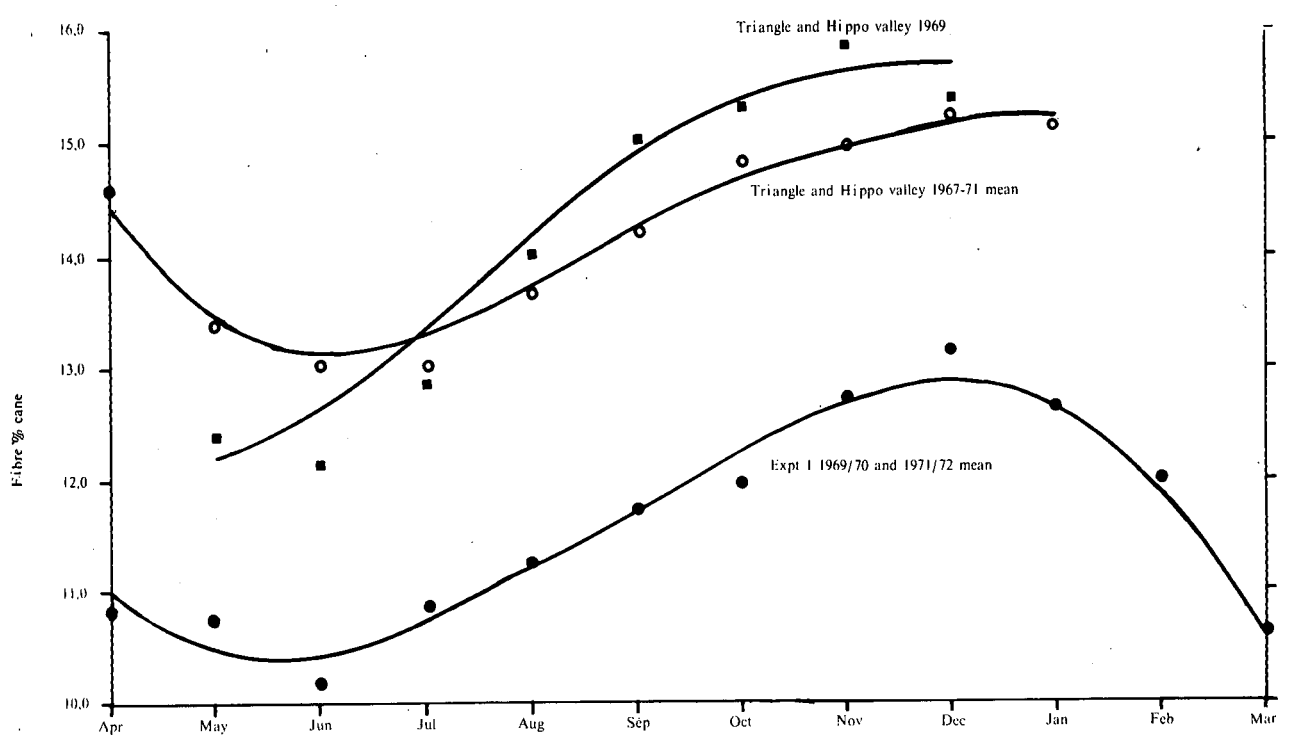
Experiments

Figure 2 shows the effect of season on the sucrose content of the four varieties mentioned above as determined from Experiment No 1, for the means of plant and 1st ratoon (11-17 month cane 1969/70, and 11-14 month cane 1971/72).

Figure 2 generally confirms the conclusions obtained from the field data, viz. CP 29-116 was closest in sucrose to the other varieties in October-January, and should be cut exclusively at this time. NCo 310 had its greatest advantage over NCo 376 during the months June-October, and should therefore be cut as a midseason variety in order to obtain maximum sugar yields from the fields. Unfortunately this would be a disadvantage from the milling point of view as it would acc-



2. Sucrose % cane data from Experiment No. 1.



3. Average fibre % cane data from Hippo Valley and Triangle during 1967-1971 and in 1969 and in Experiment No. 1.

entuate the natural seasonal variability in sucrose content. Co 462 appears to have given a generally higher sucrose content than NCo 376, but results have been rather variable. This is probably related to the high degree of lodging found in this variety.

The lowest sucrose % cane was generally obtained in April.

Fibre content

Estate data

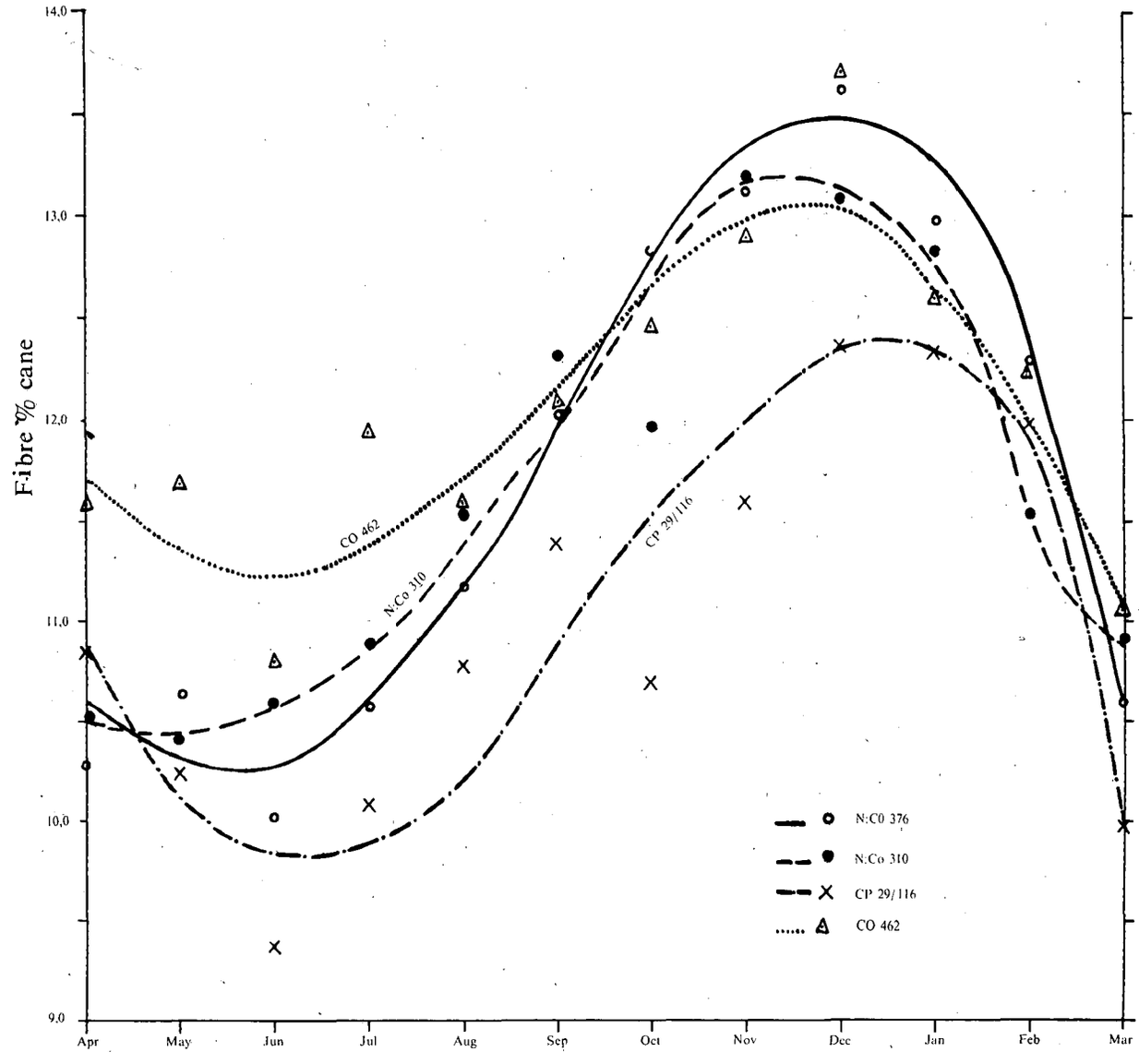
Figure 3 shows the variation in average fibre content during the season for the two mills over the five years 1967-71, together with the mean fibre data for all varieties in Experiment No 1. In addition, the curve for 1969 mill data is shown separately. In 1969, flowering of cane was very much more severe than in any of the other years from 1967 until 1971. Mean counts of flowers per hectare at the Experiment station in NCo 310 in one experiment were:
1967 - 510; 1968 - 1580; 1969 - 6350; 1970 - 0; 1971 - 0.

Flower emergence commenced in June, and increased steadily until October. This is probably the reason for the steep rise in fibre content in 1969 compared with the other seasons.

Experiments

Figure 4 shows the effect of season on the fibre content of each of the four varieties averaged for 1969/70, and 1971/72 taken from Experiment No 1.

All varieties showed a marked increase in fibre content during the milling season, reaching a peak in December, about 3 months later than the sucrose peak. There was then a fairly rapid drop in fibre content until a low point was reached in June, also some 3 months later than the sucrose trough in March. The reasons for this seasonal fluctuation do not appear to be related to moisture stress as the experiment was uniformly irrigated, using control based on Class "A" Pan evaporation throughout the year; no drying-off was practised. In addition, care was taken to



4. Fibre % cane in Experiment No. 1.

carry out each monthly harvest shortly after an irrigation in order to avoid moisture stress. Data from Gosnell[2] and elsewhere indicate that moisture stress may reduce fibre content and high moisture status may increase it. The period of peak evaporative demand when moisture stress in commercial cane is most likely to occur, is October-November; this does not account for the above seasonal fluctuation, which was observed equally in commercial and experimental cane. On the other hand there were significant correlations between fibre content and temperature or radiation, as shown in the "r" values given below:

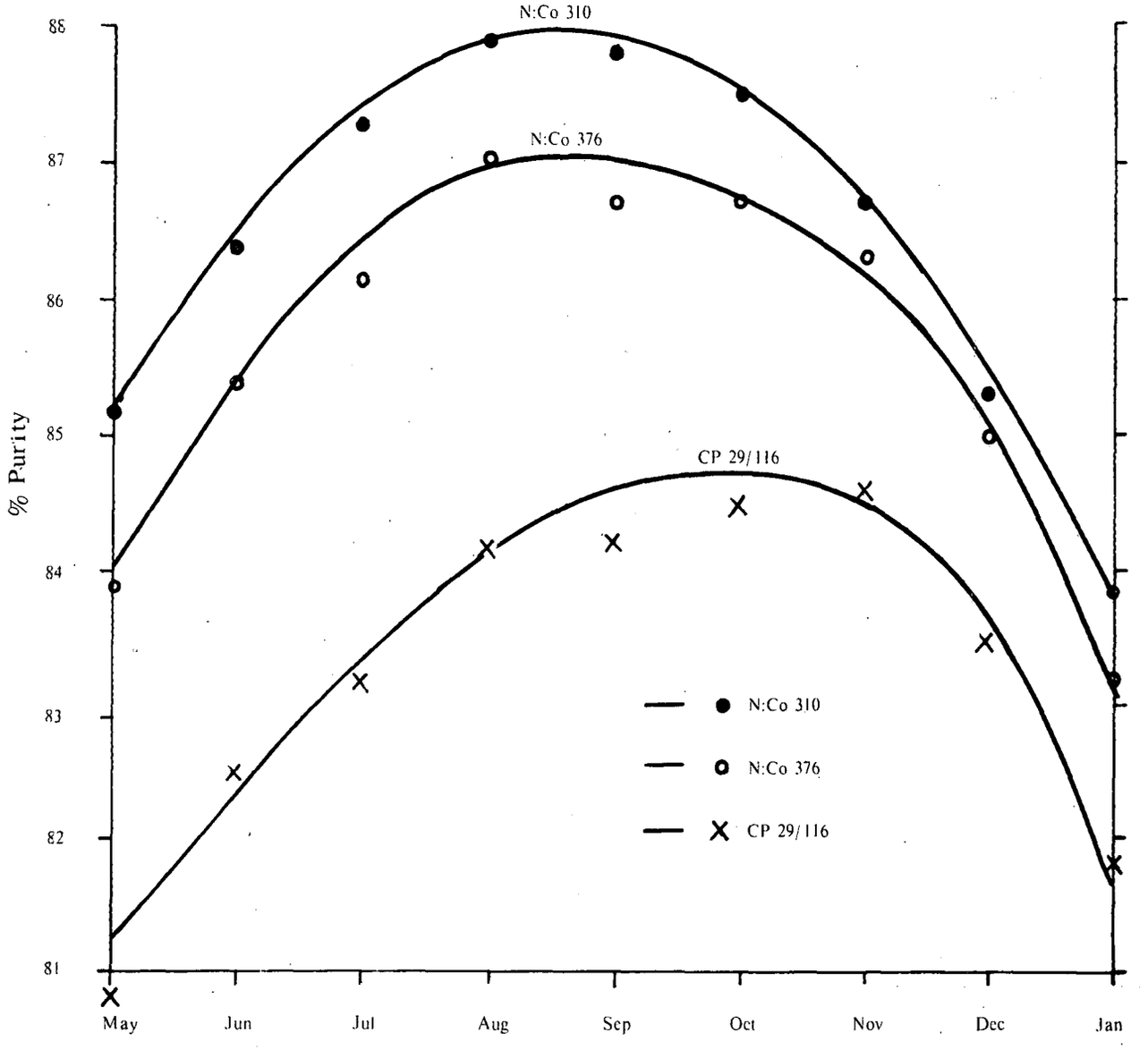
Fibre correlation with:	1969/70	1971/72
Mean temperature	0,780***	0,510
Maximum temperature	0,529	0,593*
Minimum temperature	0,781***	0,467
Solar radiation	0,609*	0,644*

The fibre content therfore appears to reflect the rate of growth at any particular time of year.

In general the behaviour of the four varieties was similar; however, some points of difference are of interest. Fibre content of CP 29-116 tended to peak later than that of the other varieties; this was similar to the pattern with the sucrose content of this variety which also peaked a month later than that of the other varieties. Co 462 generally had a higher fibre content than the other varieties; this was more marked in the low fibre months of May-June. The fibre contents of NCo 376 and NCo 310 were very similar.

Purity

Figure 5 shows the purity for the three main varieties for Triangle over the period 1966-71.



5. Juice purity at Triangle, 1966—1971.

Juice purities for NCo 376 and NCo 310 showed a steady rise from May to a peak in August, a month earlier than the sucrose peak. The drop in purity from August to September (while sucrose was rising) was due to a rapid rise in brix which was probably caused by warmer weather conditions promoting active growth. CP 29-116 peaked during September-October, also a month earlier than the sucrose peak. With regard to the differences between varieties, the trends were similar to those of sucrose content, viz. CP 29-116 had a much lower purity throughout the season except in November-December, when it was only slightly lower than the other varieties. NCo 310 juice purity was higher than that of NCo 376 during the beginning and middle of the season, but the difference dropped considerably towards the end of the season.

Due to incomplete brix analyses, the purity data from Experiment No. 1. have been omitted.

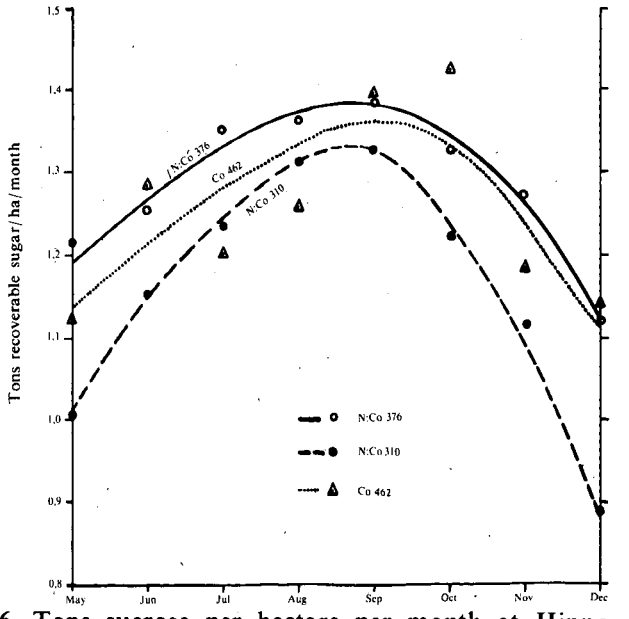
Sucrose production per hectare

In the final analysis, decisions on the optimum month of harvest for each variety must depend on the tons sucrose per hectare per month for these varieties. These data are given for Hippo Valley Estates for the period 1968-71 in Table 2 in Figure 6.

TABLE II

Mean tons sucrose per hectare per month for three varieties at Hippo Valley Estates

MONTH	1968	1969	1970	1971	MEAN
NCo 310					
May	—	—	1,036	1,062	1,049
Jun	1,051	1,157	1,152	1,294	1,164
Jul	1,101	1,275	1,229	1,335	1,235
Aug	1,134	1,258	1,430	1,424	1,312
Sep	1,211	1,356	1,332	1,407	1,326
Oct	1,123	1,206	1,318	1,242	1,222
Nov	0,942	1,074	1,233	1,214	1,116
Dec	0,495	0,800	1,103	1,158	0,889
NCo 376					
May	—	—	1,177	1,256	1,216
Jun	1,045	1,332	1,273	1,360	1,252
Jul	1,116	1,318	1,491	1,477	1,350
Aug	1,137	1,368	1,406	1,527	1,360
Sep	1,125	1,368	1,437	1,597	1,382
Oct	1,161	1,330	1,394	1,411	1,324
Nov	1,159	1,267	1,372	1,286	1,271
Dec	0,738	1,141	1,309	1,283	1,118
Co 462					
May			1,036	1,213	1,124
Jun			1,334	1,230	1,282
Jul			1,157	1,246	1,202
Aug			1,231	1,288	1,260
Sep			1,417	1,354	1,386
Oct			1,330	1,527	1,428
Nov			1,197	1,176	1,186
Dec			1,166	1,111	1,138



6. Tons sucrose per hectare per month at Hippo Valley, 1968—1971.

Figure 6 shows that NCo 376 produced the highest yields of sucrose per hectare month throughout the season followed by Co 462 and NCo 310. The differences between NCo 376 and NCo 310 were least (0,05 ts/ha/month) in August-September but was substantially greater at the beginning and end of the season, being of the order of 0,20 ts/ha/month at these times. The conclusion is clearly that NCo 310 should be harvested in the middle and not at the beginning or end of the season. NCo 376 has a flatter peak than the other varieties and can therefore be harvested at any time. Co 462 tends to show high values towards the end of the season, and also fairly high values at the beginning. Evidence so far indicates that Co 462 should not be harvested at midseason; however, insufficient data are as yet available for this variety for firm conclusions to be drawn. In comparing the sucrose production per hectare of Co 462 with that of NCo 376 it should be remembered that Co 462 was only harvested in 1970 and 1971 and that there was a steady rise in yields from 1968 to 1971 (see Table 2).

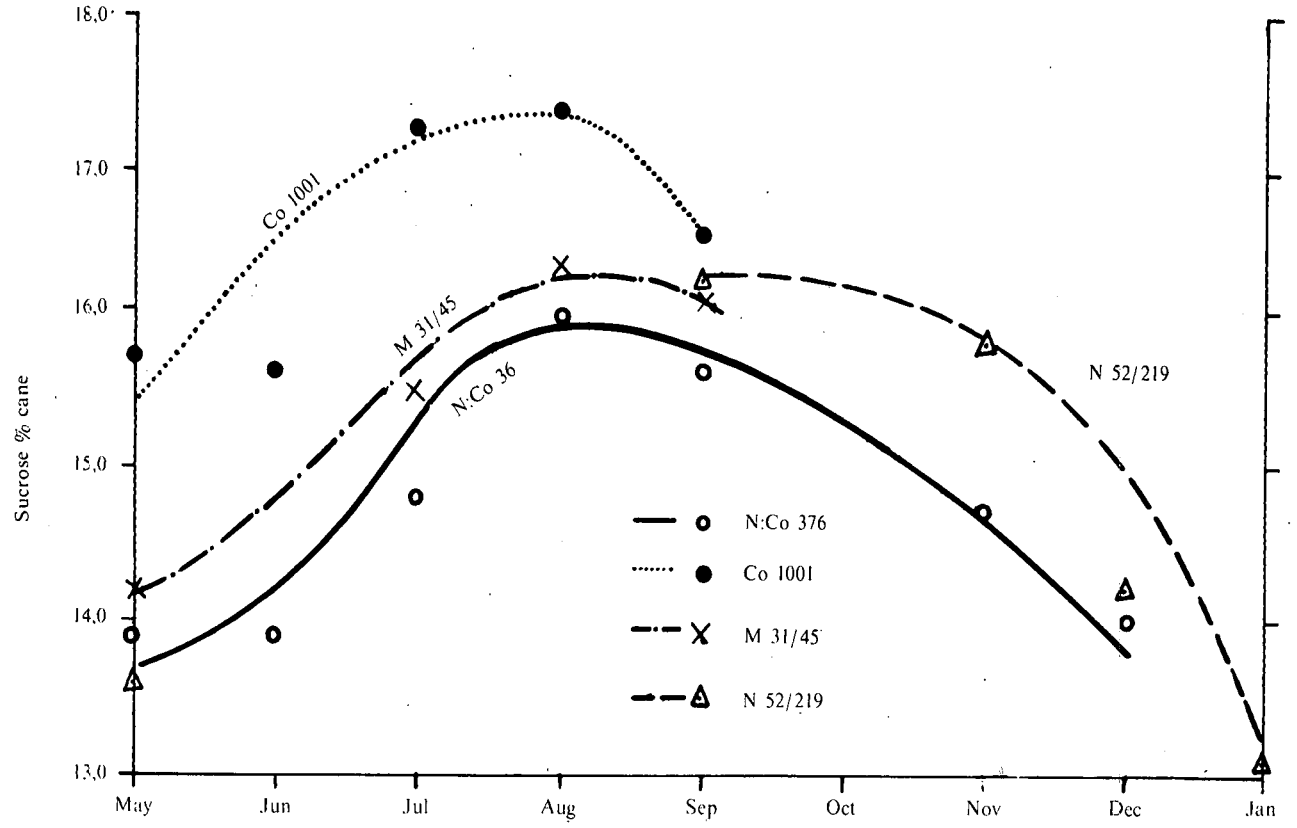
Pre-release varieties

During the last two years, three additional varieties have been granted pre-release status: M 31-45, Co 1001 and N 52-219.

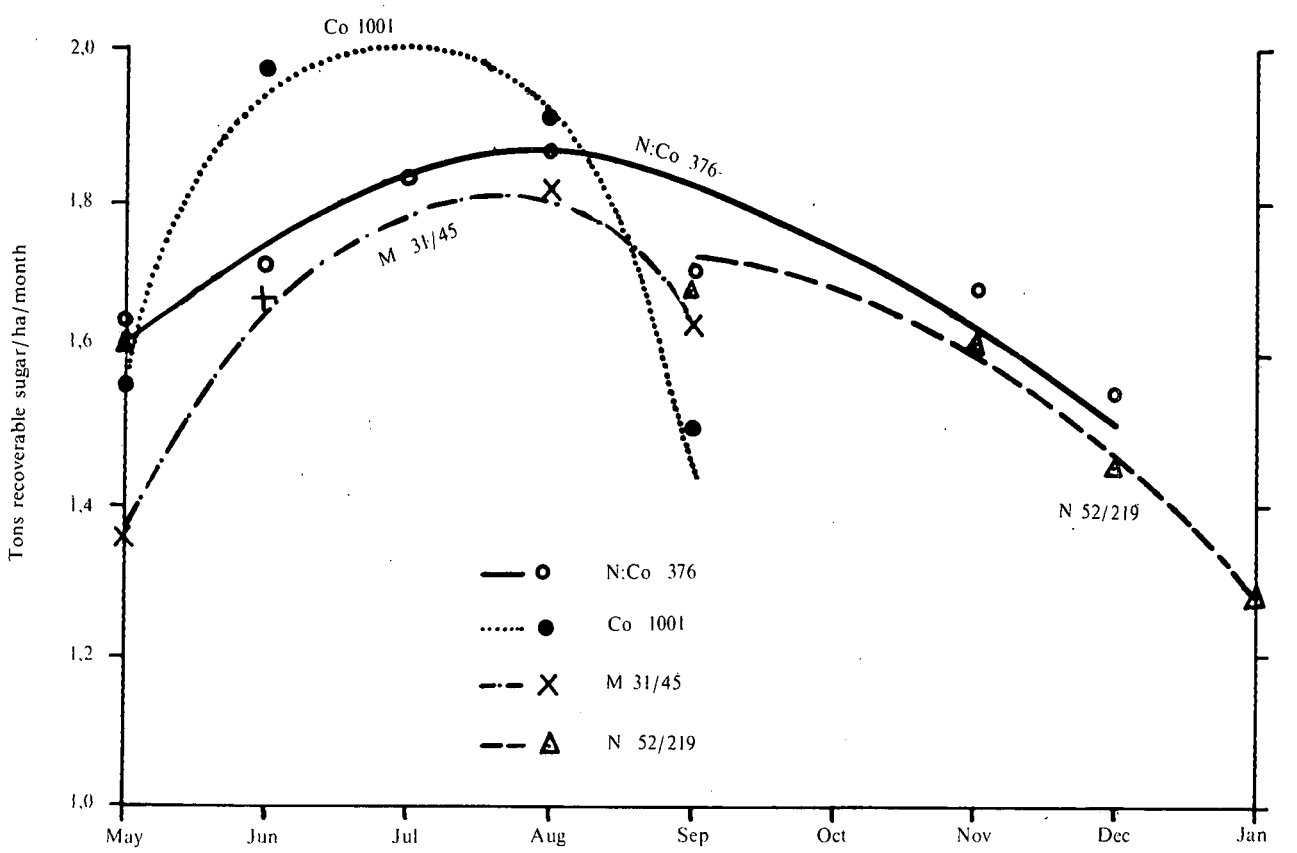
Figures 7 and 8 show the sucrose % cane and tons recoverable sugar per hectare per month from available data from variety trials. Whilst very incomplete, it would appear from both these graphs that Co 1001 should be harvested early to mid-season, M 31-45 in mid-season and N 52-219 from mid to late-season.

Discussion

The main conclusions from the data presented are that the optimum times fo season for harvesting each of the four released varieties are as follows:-NCo 310 during August-September; CP 29-116 during November-



7. Sucrose % cane data for pre-release varieties.



8. Tons recoverable sugar per hectare per month for pre-release varieties.

December; Co 462 from October to December; while NCo 376 may be harvested at all time of year. In the case of NCo 310 and CP 29-116, the data indicate substantial changes from established practices, since NCo 310 has generally been harvested at the beginning and end of the season and CP 29-116 at all times, but usually early in the season. From the above, it is evident that there is a need for an early maturing variety, and Co 1001 may be of use in this respect.

It is also of value to reach conclusions on the optimum months for starting and finishing the harvesting season. When looking at the rapid drop in cane quality towards the end, one is inclined to think that terminating the milling season as soon as possible after November can only be beneficial, bearing in mind the following:

1) Fibre is highest in December and rain must make matters worse, both in the fields and the mill.
2) Sucrose recovery becomes difficult, because of the rapid fall-off in purity.
3) In order to take maximum advantage of available radiation for photosynthesis, it is desirable for the cane canopy to be well developed before the peak radiation period (October—February). This suggests that both the beginning and ending of the harvesting season should be brought forward.

It is of interest to note that this is precisely what has happened over the last four years. Whereas the milling season ran from June-January some years ago, it now runs from April-December. However, the sucrose trough in March generally means that low sucrose values can be expected in April, and since adequate drying-off is not possible at this time of year, there may be a place for chemical ripeners here.

Acknowledgements

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