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Effect of age-at-harvest on sugarcane (*Saccharum officinarum* ..) yields in southwestern Nigeria.

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Abstract

The experiment testing the effect of age-at-harvest on sugarcane showed that standing-over significantly reduced cane and sugar yields. Highest yields were obtained from 15 month-old crops. Standing-over reduced yields by increasing the percentage of unmillable cane stalks. The need to develop suitable and more adaptable cultivars is highlighted.

Introduction

Previous works (Barnes, 1964; King *et al.*, 1965; Humbert, 1968) showed that the growth period of plant cane and ratoon crops varies considerably. It is greatly influenced by factors such as varietal characteristics, time of planting, climate, rainfall, operational procedure and the general cropping plans for particular plantations. Barnes (1964) described the period and type of cane grown from the time of one planting to the succeeding one on the same land as 'crop cycle'. He reported that a crop cycle varied considerably on an estate or farm and could alter in one field because of changes in cane varieties and/or the effect of improved cultural practice.

Plant cane in most places within the tropics occupies the land for a minimum of 12 months and a maximum of 18. But in some cane growing countries especially where annual rainfall is below the optimum for sugarcane production, the cane is usually allowed to grow through two seasons. For instance, in Hawali, plant cane and ratoons are harvested at 24 months or even later (Humbert, 1968). In Nigeria, a crop of cane planted in March/April is ready for harvest in November/December (Ogunremi, 1977). Subsequent ratoons from such harvested plant canes mature in 12 months. Potential gains or otherwise in allowing a cane crop to 'stand

over' more than a year are not yet known in Nigeria. Anticipated higher economic returns that might likely result from longer cane cropping period, stimulated the interest in an evaluation of cane production at different ages of harvest.

Thus, the main objective of the work reported here was to estimate the optimum age at which to harvest a cane crop for maximum yield in Southern Nigeria.

Material and Methods

The experiment was conducted in the rainforest zone at Ikoya, Okitipupa ($6^{o}30\frac{1}{2}'N$, $4^{o}45'E$) on a well-drained virgin soil type grouped under the 'Ferralitic Tropic Soils' (D'Hoore, 1964). Physical characteristics of the soil (Ashaye and Jaiveola, 1972) are shown in Table 1. Planting was done in March, 1974. The treatments consisted of three sugarcane cultivars: (V_1) H38/2915, (V_2) B46364, (V_3) Pindar; and five ages-at-harvest namely (T_1) 12, (T_2) 15, (T_3) 18, (T_4) 21 and (T_5) 24 months after planting. These treatments were tested in a split-plot design, cultivars being the main plot and cutting times, the sub-plots. There were four replications. Gross plot was $40m^2$ while the nett was $34m^2$.

Planting was done by hand on the flat, burying the seed canes in furrows 1.8m apart. The seed canes were sprayed with aldrin 4% (w/v) at planting. Basal dressings of NPK fertilizers were applied as ammonium sulphate, single superphosphate and sulphate of potash at the rate of 84, 50 and 112 kg/ha respectively. The same basal fertilizer dressing was applied to the ratoon immediately after cutting the plant cane. Harvesting was done by hand on dates as shown in Table 2, cutting the canes from the plot at soil level. Mature and millable canes were separated from dead, immature and unmillable ones, counted and weighed.

Random samples of millable cane stalks were taken. From these, average stalk height, internode lengths and thickness were recorded. Saw-dust samples were analysed for sucrose content of the juice adopting Horne s dry lead method (Spender and Meade, 1964). The estimated recoverable sugar was calculated using the percentage sucrose content and the cane yield.

Results

Results are summarized in Tables 3-7. It was found that yields were significantly depressed with increase in age-at-harvest. Highest yields occurred at 15 months and thereafter yields consistently decreased (Table 3). Average yields of 71 and 86 t/ha were obtained from plant cane and

ratoon respectively at 15 months. Generally, there were no effects of age-at-harvest on total number of stalks produced but percentage of millable canes was significantly reduced as age-at-harvest increased (Fig. 1). Fig. 1 shows clearly that the millable proportion of the stalk population produced, sharply fell to 50% at 18 months. Stalk height and diameter were influenced, both increasing slightly with delay in harvesting (Table 4). The internode length was not affected (Table 5) while % fibre significantly increased with delayed harvesting. Cultivar H38/2915 significantly out yielded cultivars B46264 and Pindar in cane tonnage, producing 75 and 97 t/ha as plant cane and ratoon respectively.

Sucrose content of the cane increased significantly for cultivars H38 2915 and Pindar but decreased for B4634 when the crop was allowed to standover for 15 months; thereafter it decreased sharply with increase in age-at-harvest (Table 6). Cultivar Pindar was the best in terms of percentage sucrose content. This attribute apparently compensated for its relatively lower cane yield in terms of estimated recoverable sugar (Table 7). Thus, cultivar Pindar was found to be as good as cultivar H38/2915 which was 19% better in cane tonnage. Effects of age-at-harvest on arrowing tendencies were small, though arrowing tendencies were generally high for the three cultivars. It was interesting to find however, that the 15 month treatment harvested in mid-May 1975 as plant cane, had not yet arrowed when harvested as ratoon in August, 1976.

Discussion

Yields obtained in this study compared favourably with those recorded by other workers elsewhere (Matherne, 1972; Bull, 1975 and Matherne and Irvine, 1978). That plant canes were found yielding lower than ratoons here, disagrees with Matherne and Irvine (1978) who obtained lower cane tonnage from subsequent stubble canes (i.e. ratoons) than from plant cane. The higher yields of the ratoons were apparently due mainly to longer growth period (Ogunremi, 1977).

This work has shown clearly that extending the crop cycle on sugar cane plantations could be highly uneconomic. The sharp drop in yields with increase in age-at-harvest was caused mainly by increase in the proportion of immature outgrowths, late tillers and dead stalks, resulting in lower millable stalk proportion (Fig. 1). Age and excess moisture are some of the important factors responsible for dead canes. Thus the high rainfall (Table 1) probably enhanced the effect of age-at-harvest. Occurrence of peak yields at 15 months is similar to reports from other cane growing countries, though the peak occurred much earlier. Humbert

(1968) reported peak production of sugar at 21 months for cultivar 37-1933 in Hawaii, where increased age above 24 months had been associated with poor quality cane. In Queensland, cane cultivars such as C.P. 29–116 are normally allowed to grow for two seasons, reaching the first peak at 15 months and the second, at 22 months (King et al., 1965). In contrast to the Queensland workers, data obtained in this investigation showed that leaving a cane crop to standover for 24 months, resulted in 54% and 40% of the 15 month – peaks from plant cane and ratoon respectively. The decrease in percentage sucrose content with increase in age confirmed Glasziou's (1960) report that the rate of accumulation of both sucrose and glucose falls rapidly with age of the storage tissue.

That the 15 month treatment ratoon in this study did not flower was interesting. This could be a pointer to the significance of synchronization of floral initiation with required daylength as well as the need to investigate in detail the physiological basis of the effect of age-at-harvest on ratoon flowering. Mangelsdorf (1950) had shown that each cane cultivar has its particular daylength range within which floral initiation may occur, provided other factors are favourable. The work of Paliatseas and Chilton (1956) had also shown clearly that flowering is a chain of physiological processes including floral initiation, floral organisation, floral maturation and emergence. Since sugarcane is a short day plant that flowers only if the light period is made shorter than the critical, a plausible explanation for the non-flowering of the 15 month treatment ratoon could be that the floral initiation stage did not coincide with the required light period. It must be recalled that this particular treatment was cut as plant cane in May (Table 2) indicating that the flower primordia differentiation stage of the ratoon should have occurred at a period in the growing season different from that of the plant cane planted in March. However, the fact that standing-over in this work had no effect on the arrowing tendencies of the cultivars used, highlights the need for specific breeding programmes to develop suitable and more adaptable non-flowering cultivars for large scale plantation production in Southern Nigeria.

TABLE 1: PHYSICAL CHARACTERISTICS OF THE SOIL AND TOTAL RAINFALL (mm) FOR 1974-1977, AT IKOYA, OKITIPUPA

Depth (cm)	PH	Particles size composition % Coarse sand	Fine sand	Silt	Clay	% Organic Carbon	% Total Nitrogen	Rainfall Year	Amount (mm)
0 - 15	6.30	55.65	16.52	7.20	17.24	3.15	0.24	1974	1601
15 - 30	6.30	48.73	14.39	7.13	28.97	0.72	0.06	1975	1763
30 - 60	5.60	37.79	8.16	8.10	45.38	0.52	0.05	1976	1811
								1977	1744

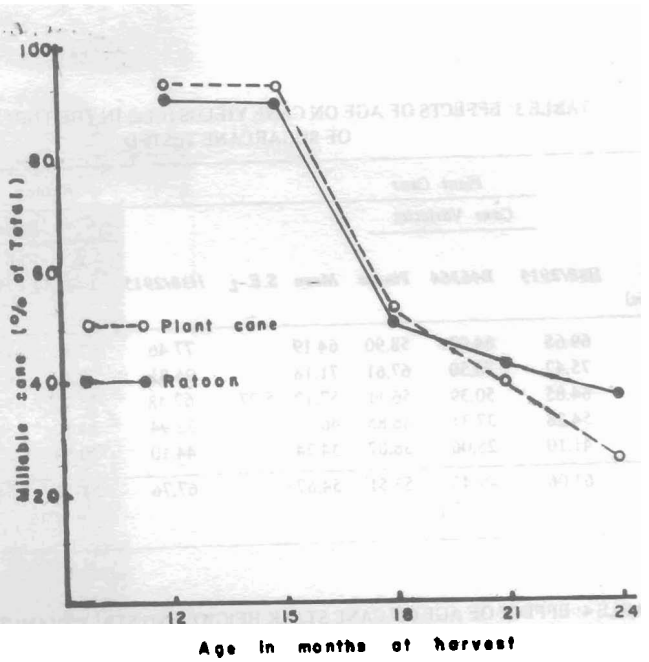

FIG. 1. Effect of age-at-harvest on percentage millable cane stalk population

TABLE 2: DATES OF HARVEST OF PLANT CANES AND THEIR RATOONS IN THE SUGARCANE VARIETIES TESTED.

Treatment Ages (months)-at-harvest	*Dates of harvest*	
	Plant cane	*Ratoon*
T_1 12	1st week, Feb. 1975	Mid Feb. 1976
T_2 15	Mid May, 1975	3rd week, August, 1976
T_3 18	Mid August, 1975	1st week, February, 1977
T_4 21	Last week, Nov. 1975	Mid August, 1977
T_5 24	Last week, Jan. 1976	Mid January, 1978.

TABLE 3: EFFECTS OF AGE ON CANE YIELDS (t/ha) IN THE THREE VARIETIES OF SUGARCANE TESTED

	Plant Cane					*Ratoon*				
	Cane Varieties					*Cane Varieties*				
Age-at-harvest (Months)	*H38/2915*	*B46364*	*Pindar*	*Mean*	*S.E. ±*	*H38/2915*	*B46364*	*Pindar*	*Mean*	*S.E. ±*
12	69.65	64.02	58.90	64 19		77.46	67.86	74.83	73.38	
15	75.42	70.50	67.61	71.18		96.81	78.20	82.50	85.84	
18	64.85	50.39	56.11	57.12	5.97	67.48	55.70	52.91	58.70	6.55
21	54.28	37.31	46.85	46.15		52.94	34.10	38.61	41.88	
24	41.10	25.06	38.07	34.74		44.10	20.59	23.93	29.54	
Mean	61.06	49.45	53.51	54.67		67.76	51.29	54.56	57.87	
S.E. ±		3.17					4.46			

TABLE 4: EFFECT OF AGE ON CANE STALK HEIGHT AND STALK DIAMETER IN THE THREE VARIETIES OF SUGARCANE TESTED

	Stalk height (m)					*Stalk diameter (cm)*				
	Varieties					*Varieties*				
Age-at-harvest (Months)	*H38/2915*	*B46364*	*Pindar*	*Mean*	*S.E. ±*	*H38/2915*	*B46364*	*Pindar*	*Mean*	*S.E. ±*
12	2.31	2.18	2.15	2.21		2.11	2.23	2.18	2.17	
15	2.52	2.49	2.50	2.50		2.58	2.79	2.33	2.57	
18	2.48	2.39	2.47	2.45	0.62	2.37	2.48	2.21	2.35	0.46
21	2.49	2.41	2.46	2.45		2.19	2.03	2.11	2.11	
24	2.37	2.42	2.51	2.43		1.98	1.93	2.00	1.97	
Mean	2.43	2.38	2.42	2.41		2.25	2.29	2.17	2.23	
S.E. ±		0.53					0,37			
					Ratoon					
12	2.52	2.39	2.62	2.51		2.63	2.54	2.36	2.51	
15	3.01	3.63	2.89	3.18		2.82	2.91	2.58	2.77	
18	2.98	3.01	2.77	2.92	0.69	2.51	2.63	2.55	2.56	0.51
21	2.63	2.86	2.53	2.67		2.40	2.38	2.12	2.30	
24	2.41	2.55	2.41	2.46		2.01	2.22	1.98	2.07	
Mean	2.71	2.89	2.64	2.75		2.47	2.54	2.32	2.44	
S.E. ±		0.57					0.42			

TABLE 5: EFFECT OF AGE ON INTERNODE LENGTH AND % FIBRE IN THE THREE VARIETIES OF SUGARCANE TESTED.

	Plant Cane					*Ratoon*				
	Internode Length (cm)									
Age-at-harvest (Months)	*H38/2915*	*B46364*	*Pindar*	*Mean*	*S.E. ±*	*H38/2915*	*B46364*	*Pindar*	*Mean*	*S.E. ±*
12	12.9	12.4	12.8	12.7		13.3	13.1	12.9	13.1	
15	13.6	13.3	13.4	13.4		14.9	14.8	13.7	14.5	
18	13.1	13.0	13.2	13.1	0.71	14.7	14.6	13.8	14.4	0.82
21	12.9	12.8	13.0	12.9		14.6	14.7	13.8	14.4	
24	12.7	12.8	12.9	12.8		14.4	14.5	13.7	14.2	
Mean	13.0	12.9	13.1	13.0		14.4	14.3	13.6	14.1	
S.E. ±		0.63					0.69			
	% Fibre									
12	8.02	8.27	7.91	8.06		9.11	8.92	8.01	8.68	
15	8.62	8.87	8.44	8.64		9.07	9.42	9.37	9.29	
18	8.17	9.01	9.73	8.97	1.01	10.22	9.48	9.26	9.65	1.12
21	9.89	10.33	11.41	10.54		11.17	10.36	13.17	11.57	
24	11.81	12.11	13.82	12.58		12.57	12.43	14.61	13.20	
Mean	9.30	9 72	10.26	9.76		10.43	10.12	10.88	10.48	
S.E. +		0.83					0.91			

TABLE 6: EFFECTS OF AGE ON % SUCROSE CONTENT IN THE THREE VARIETIES OF SUGARCANE TESTED

	Plant Cane					*Ratoon*				
Age-at-harvest (Months)	*H38/2915*	*B46364*	*Pindar*	*Mean*	*S.E. ±*	*H38/2915*	*B46364*	*Pindar*	*Mean*	*S.E. ±*
12	11.59	12.63	15.99	13.40		11.94	11.86	16.08	13.29	
15	13.52	10.75	17.21	13.83		13.34	9.92	16.01	13.09	
18	10.66	10.85	12.79	11.43	0.67	11.25	10.62	12.47	11.45	0.55
21	7.83	7.78	7.97	7.86		8.44	8.18	7.69	8.10	
24	6.19	5.96	6.80	6.32		6.59	7.33	7.18	7.03	
Mean	9.96	9.59	12.15	10.57		10.31	9.58	11.89	10.59	
S.E. ±		0.83					0.47			

TABLE 7: EFFECTS OF AGE ON ESTIMATED RECOVERABLE SUGAR (t/ha) IN THE THREE VARIETIES OF SUGARCANE TESTED

	Plant Cane					*Ratoon*				
Age-at-harvest (Months)	*H38/2915*	*B46364*	*Pindar*	*Mean*	*S.E. ±*	*H38/2915*	*B46364*	*Pindar*	*Mean*	*S.E. ±*
12	8.07	8.14	9.47	8.56		9.27	8.00	11.98	9.75	
15	10.18	7.59	11.93	9.90		12.85	7.81	13.15	11.27	
18	6.90	5.42	7.20	6.50	1.02	7.61	5.90	6.65	6.72	0.81
21	4.23	2.90	3.75	3.63		4.45	2.88	2.88	3.40	
24	2.58	1.54	2.74	2.28		2.85	1.45	1.71	2.01	
Mean	6.39	5.12	7.02	6.18		7.41	5.21	7.27	6.63	
S.E. ±		0.56					0.53			

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