EFFECTS OF FLOWERING ON SUCROSE CONTENT AND SUCROSE YIELD IN FIVE SUGARCANE VARIETIES

By K. J. NUSS

South African Sugar Association Experiment Station, Mount Edgecombe 4300

Abstract

The yield and quality traits of flowered and vegetative stalks were determined from May to October in five sugarcane varieties, and from September to December in one other variety. From July till October mass of sucrose was greater in flowered stalks than in vegetative stalks. The increase in stalk mass and sucrose content occurred mainly in the top part of the stalk. Flowered stalks of variety N11 appeared to deteriorate after October, probably because of the absence of side shoots.

Introduction

Flowering has frequently been reported to reduce yields of sugar in sugarcane. In Barbados in a variety which flowered at the age of eight months the flowered stalks weighed less than non-flowered stalks at the time of harvest (Rao[7]). Similarly, in Hawaii, flowering was reported to affect the yield of sucrose if the cane flowered in the first year of a two year crop (Clements, as quoted by Moore and Nuss[6]). However, in variety NCo376, flowered stalks were found to contain more sugar than non-flowered stalks (Gosnell and Long[1]). In a detailed investigation in Mauritius Julien and co-workers (Julien *et al*[2,3,4]) found flowered stalks to contain more sucrose than vegetative stalks for up to four months after anthesis, as long as the flowered stalks had produced side shoots. The increase was due to a greater fresh mass and more sucrose in tops of flowered stalks.

The effect of flowering on sucrose yield has been little studied in South Africa. This paper presents results to show the effect of flowering on cane yield and quality traits of five varieties sampled from May to October, and of one variety sampled from September to December.

Materials and Methods

Trial 1

Five varieties were included in three replications: NCo376, the major commercial variety which flowers profusely on rare occasions only; NCo310 and N55/805, varieties which flower freely with little apparent effect on sucrose yield; and N52/219 and N11 which flower profusely and seemingly lose yield as a result.

The plots consisted of 8 rows 14 m long and 1,5 m apart. Flowering was prevented in half of each plot by night light breaks of two hours, from 15 February to 30 March in 1981. The lights, 100 w incandescent globes at 1 m intervals, were suspended between two cane rows 1 to 1,2 m above the canopy. The height above the canopy was adjusted as the cane grew taller. The cane was sampled on 18 May (one month before flower emergence), 14 July, 11 August, 15 September and 11 October. On each date twenty stalks were then taken at random from a sub plot, 4 rows × 1,5 m in size, in the lighted plots (artificial vegetative - AV), and 20 stalks with flowers (F) and 20 without flowers (natural vegetative - NV), from a subplot of the same size in non-lighted plots. The stalks were divided into the base (0,75 m) and the top (rest of the stalk). These samples were then subjected to quality analysis.

Trial 2

Variety N11 was planted in 1982 in the field that had been used for trial 1, with the same design and lighting. Because of a drought the cane was cut back in September 1983. In 1984, flowering was prevented in the designated plots by switching on the lights at 04h30 till sunrise from 15 February to 30 March. On 23 September, 22 October, 19 November and 12 December samples of 20 flowered (F) stalks from non-lighted plots and of 20 non-flowered (AV) stalks from lighted plots were taken for sucrose analysis. Another set of 20 stalks from each treatment was divided into the base (0,75 m) and top (rest of the stalk).

Results and discussion

Trial 1

There was no flowering in the lighted plots. In the non-lighted plots flowering, which occurred in June, was not profuse, with only 9% of NCo376, 31% of NCo310, 23% of N55/805, 43% of N52/219 and 42% of N11 stalks flowering.

Table 1

Mean dry matter % cane, fibre % cane and brix values of flowered (F), natural vegetative (NV), and artificially induced vegetative (AV) stalks of five varieties

	Type of stalk	Sampling date				
		18 May	14 July	11 Aug	15 Sept	12 Oct
Dry matter % cane	F	–	27,2	28,4	29,0	29,6
	NV	24,0	26,4	27,8	28,7	29,0
	AV	24,4	27,0	27,9	28,4	29,0
Fibre % cane	F	–	11,3	11,5	12,3	12,3
	NV	10,0	11,0	11,6	12,1	12,4
	AV	9,8	11,2	11,5	12,1	12,6
Brix % cane	F	–	16,0	16,9	16,8	17,3
	NV	14,1	15,6	16,3	16,6	16,7
	AV	14,5	15,7	16,4	16,3	16,3

Some quality traits are given in Table 1. There were no major differences in respect of % dry matter, fibre content and brix between F, NV and AV stalks in any of the varieties. Dry matter, fibre and brix contents increased to about the same extent in flowered and non-flowered stalks between May and October.

Increases in pol % cane were more rapid in the top part of the stalk than in the stalk as a whole (Figure 1). With varieties NCo376 and NCo310 the final (October) pol % cane values were somewhat lower in AV than in F and NV stalks; with the other three varieties differences were negligible.

By July both the fresh mass (not shown) and the mass of pol per stalk of F stalks were greater than those of AV and NV stalks (Figure 2). Although there is a tendency for heavier stalks to flower and lighter stalks not (Julien *et al*[4]) the flowered stalks in this trial and those tested in Mauritius also, increased faster in fresh mass and sucrose content than artificially vegetative stalks after the initiation of inflorescences.

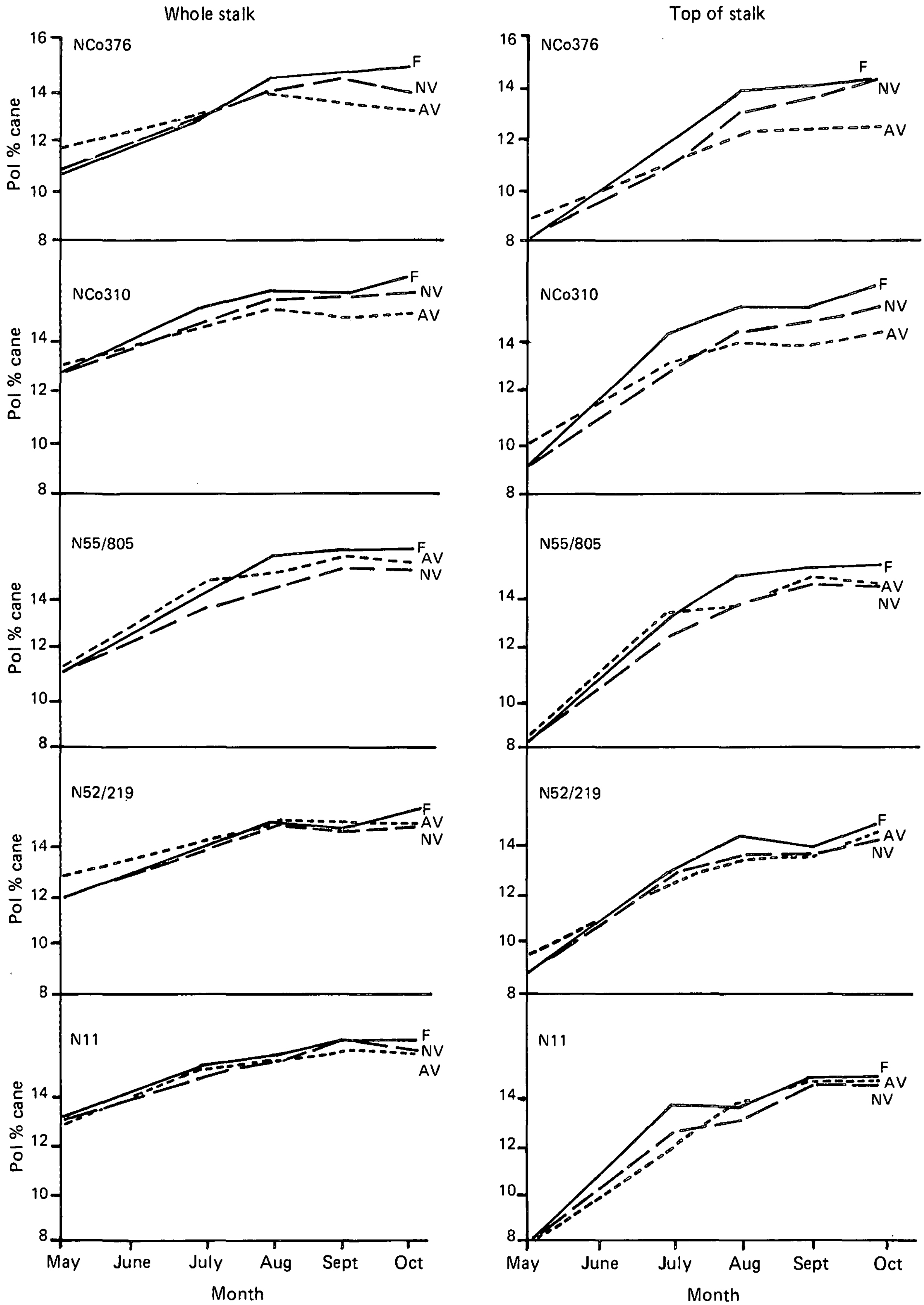

FIGURE 1 Pol % Cane in whole stalks and tops of flowered (F) natural vegetative (NV) and artificial vegetative (AV) stalks of five varieties sampled from May to October.

Most of the increase in mass pol per stalk after July took place in the tops of the stalks. In flowered plots F stalks accumulated sucrose (mass pol) more rapidly than NV stalks. Increases in mass pol were similar in NV and AV stalks of NCo376 and N55/805; in NCo310 mass pol of AV stalks reached an intermediate level between those of F and NV stalks; in N52/219 and N11 mass pol of AV stalks increased at a rate such as to equal the mass pol of F stalks by October. In the case of N11, at least, the similar final pol masses of AV and F stalks can be explained by the commonly observed tendency in this variety, for leaves on flowering stalks to senesce comparatively quickly, with consequently impaired production of photosynthate to support sucrose accumulation. No side shoots had developed by that date. It can be seen (Figure 2) that there was little increase after August in the mass pol of F stalks of N11.

Estimates of changes with time in mean pol yields of flowering and non-flowering plots were derived from the values shown in Figure 2 and the observed percentages of stalks flowering in the respective varieties. Differences in yield between lighted and non-lighted plots within varieties were generally small (Figure 3). However, the plotted points suggest that by October, in varieties N52/219 and N11, the mean pol yield per stalk in flowering plots was beginning to fall behind that in non-flowering plots.

Trial 2

Virtually all the stalks flowered in non-lighted plots and none flowered in the lighted plot, so the only possible comparisons were between F and AV stalks.

The dry matter content of F stalks of N11 decreased from September to December, by which time their dry matter content was significantly lower that that of AV stalks (Table 2). Fibre content of AV stalks increased more with time than did that of F stalks. The pol content of AV stalks remained more or less constant during the period that samples were taken but that of F stalks decreased from 15,3% in September to 13,2% in December.

Yield of cane did not differ greatly between F and AV plots (differences were never significant) and changed little with time. Differences in yield of sugar between F and AV plots were generally not significant; but while sugar yield remained nearly constant in AV plots, in F plots it apparently decreased slowly between September and December.

Table 2

Quality and yield of flowered (F) and artificially vegetative (AV) stalks of N11 in trial 2

Date of Sampling	Type of stalk	Dry matter % cane	Fibre % cane	Pol % cane	Tons cane /ha	Tons sugar /ha
September	F	29,1	13,0	15,3	74,4	11,4
	AV	29,2	13,1	15,1	81,6	12,4
	LSD (0,05)	2,1		0,5	30,6	5,1
October	F	28,6	13,0	14,8	73,9	10,9
	AV	28,7	13,1	15,0	85,8	12,8
	LSD (0,05)	2,2		0,9	31,6	4,3
November	F	28,3	14,0	13,4	73,8	9,9
	AV	29,6	14,3	14,6	77,7	11,3
	LSD (0,05)	1,6		1,3	20,5	3,7
December	F	27,8	13,7	13,2	74,1	9,8
	AV	29,9	14,4	14,9	84,8	12,7
	LSD (0,05)	0,4		1,0	15,0	0,6

The measurements made from September to November on stalks divided into bases and tops show (Table 3) that the fall in pol % cane and in sugar yield of F plots stemmed mainly from losses of sugar from the upper part of the stalk. No samples were taken in December because eldana borer had infested the trial; 77% of F stalks were damaged by eldana, with 12,6% of internodes damaged, while 68% of AV stalks and 8,7% of internodes were damaged. The approximately constant yield of sugar in AV plots up to December (Table 2) suggests that this degree of infestation did not result in much loss of yield in AV plants. Similarly, the somewhat greater degree of infestation of F stalks may not have placed much part in the fall with time in sugar yield of F plots. Small side shoots had developed in F stalks by December but were absent in stalks damaged by eldana.

Table 3

Pol % cane, mass per stalk and mass of pol per stalk of bases and tops of flowered (F) and artificial vegetative (AV) stalks of N11

Trait	Type of stalk	Time of sampling and part of stalk					
		Bases			Tops		
		Sept	Oct	Nov	Sept	Oct	Nov
Pol % cane	F	16,3	15,6	14,2	14,1	13,1	11,6
	AV	15,7	16,1	15,3	14,0	14,0	12,9
	LSD (0,05)	0,9	1,5	1,0	3,7	2,4	1,3
Fresh mass (g/stalk)	F	462	428	438	318	273	283
	AV	458	437	457	385	407	382
	LSD (0,05)	83	87	52	263	226	164
Mass Pol (g/stalk)	F	75,0	66,8	62,1	40,6	36,2	32,7
	AV	71,8	70,1	69,8	49,4	57,0	49,3
	LSD (0,05)	17,0	15,9	11,6	50,8	36,5	23,1

The results of Experiment 2 seem to be consistent with those for N11 in Experiment 1 (cf Figure 2). In both cases, with F stalks, pol % cane and mass pol per stalk were at a maximum in September and had apparently begun decreasing by October. With AV stalks there was little increase in pol % cane after September in either experiment. Mass pol per stalk of AV stalks remained approximately constant after September in Experiment 2 and the trend of the plotted points (Figure 2) is constant, with mass pol of N11 reaching a maximum in about October in Experiment 1.

Conclusion

In South Africa flowering is not normally profuse in most varieties. In the weeks following anthesis, in partially flowering fields, mass of sucrose in stalks with flowers is greater than that of vegetative stalks. After anthesis flowering stalks gain weight faster than non-flowering stalks, probably until early summer (say November) in most varieties. Where there is no flowering (prevented with lights) stalks usually gain weight more slowly than do flowering stalks; rather they gain weight at a similar rate to or somewhat faster than non-flowering stalks in partially flowering fields. By early summer, however, in varieties where senescence of leaves on flowering stalks is comparatively rapid, the mass of sucrose per stalk in non-flowering fields may catch up with that of flowering stalks in partially flowering fields.

Accordingly, yield of sucrose per hectare is generally little affected by flowering at least until early summer (see Figure 3). In certain varieties, however, if flowering is heavy, yield of sucrose is likely to fall if harvesting is delayed until mid to late summer. Experiment 1 was terminated too soon (in any case flowering in it was generally sparse) to show whether yield in a range of varieties is likely to be affected if the harvesting of heavily flowering fields is delayed until late summer. In Zimbabwe there was a substantial fall in pol % cane of flowered stalks of NCo376 when the crop was carried over for harvesting in the following season (Long[5]).

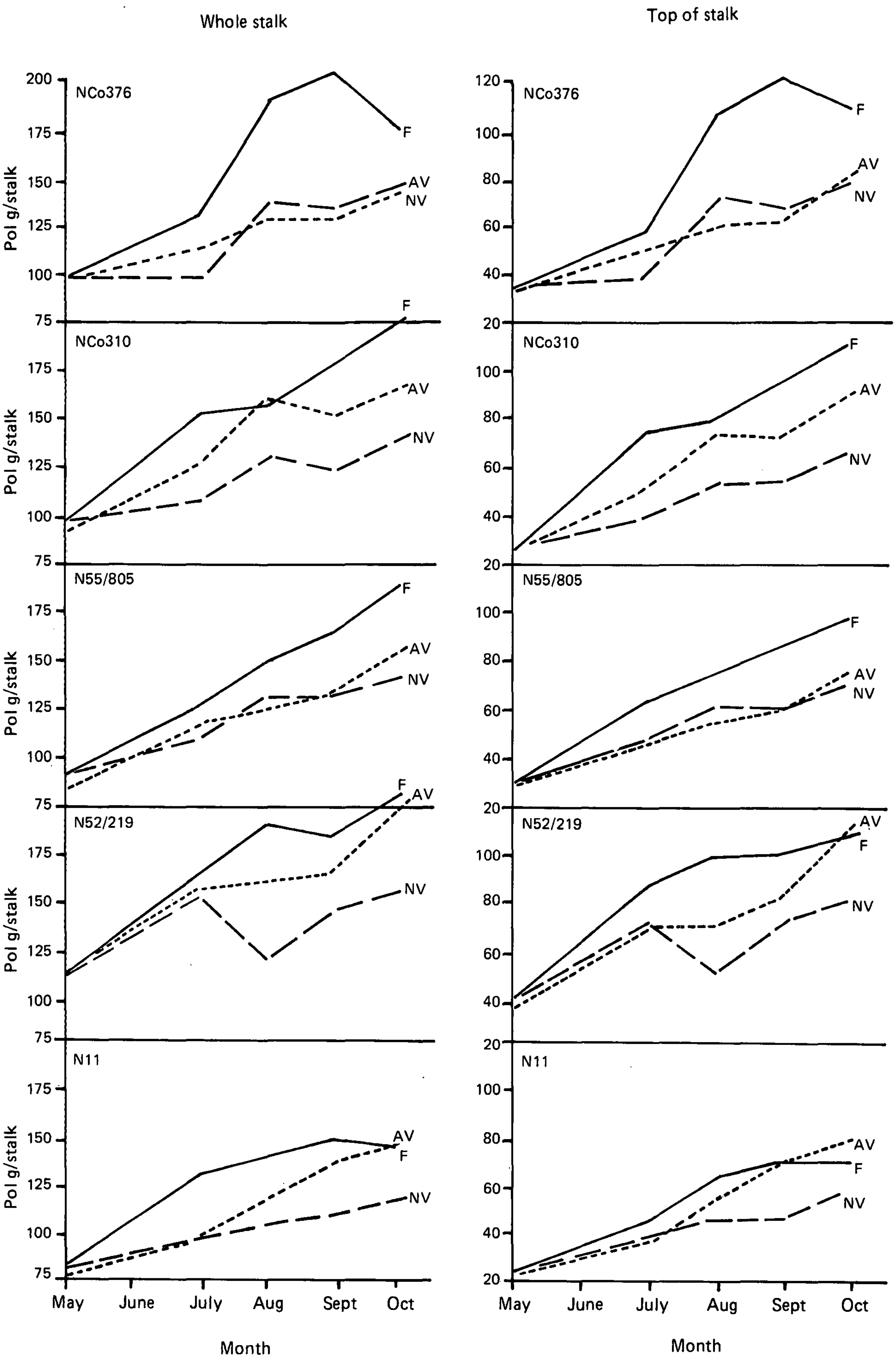

FIGURE 2 Mass of pol (g/stalk) of flowered (F) natural vegetative (NV) and artificial vegetative (AV) stalks and tops of five varieties sampled from May to October.

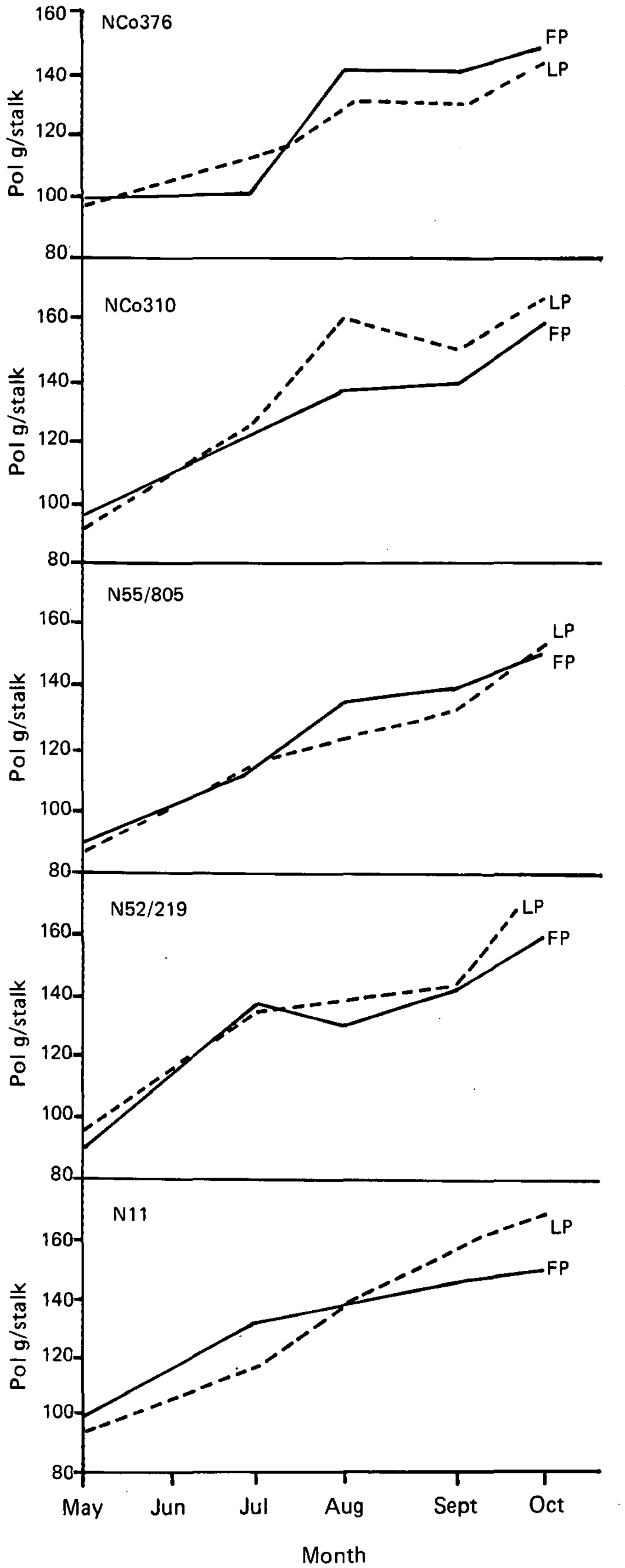

FIGURE 3 Changes with time in estimated mean pol yield (g/stalk) of lighted (LP=non flowering) and flowering (FP) plots of five varieties.

REFERENCES

1. Gosnell, GM and Long, AC (1973). A comparison of yield and quality between flowered and non-flowered cane. *Proc S Afr Sug Technol Ass* 47: 148–166.
2. Julien, MHR and Soopramanien, GC (1976). The effect of flowering on yield in sugarcane. *Rev agric et sucr Ile Maurice* 55: 560–509.
3. Julien, MHR; Delaveau, P; Soopramanien, GC and Matine, JF (1977). Age, time of harvest and environment as factors influencing differences in yield between flowering and vegetative canes. *Proc int Soc Sug Cane Technol* 16: 1771–1790.
4. Julien, MHR; Soopramanien, GC; Martine, JF and Medan, H (1980). The role of side shoots in flowered stalks of sugarcane. *Proc int Soc Sug Cane Technol* 17: 571–582.
5. Long, AC (1976). A large varietal difference in cane deterioration due to flowering. *Proc S Afr Sug Technol Ass* 50: 78–81.
6. Moore, PH and Nuss, KJ (1987). Flowering and flower synchronization. In Heinz, DJ (ed) *Sugarcane Improvement through Breeding*, pp 273–311. Elsevier, Amsterdam.
7. Rao, PS (1977). Effects of flowering on yields and quality of sugarcane. *Ex Agric* 13: 381–387.