EFFECTS OF PHOTOPERIOD AND TEMPERATURE ON THE RATE OF ELONGATION OF SUGARCANE LEAF SHEATHS

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Abstract

The rate of leaf sheath elongation of flowering sugarcane stalks was measured on five varieties in six photoperiod treatments. A constant daylength of 12,5 h reduced the elongation rate of the leaf sheaths compared with a declining daylength and resulted in a prolonged period of time from initiation to emergence. A rate of decline in day length of fifty seconds per day after initiation resulted in the fastest leaf sheath elongation. The elongation rate of the leaf sheaths was slower when the decline was only thirty seconds per day. Temperature affected the elongation rate and final length of the leaf sheath.

Introduction

Some sugarcane varieties do not flower naturally in Natal because of its distance from the equator. A photoperiod house, where the hours of day-length could be controlled, was constructed in 1970 and since then most local and imported varieties have been induced to flower (Brett and Harding[1]).

MacColl[6] described the following phases of flowering in sugarcane:

(i) induction
(ii) differentiation of inflorescence
(iii) elongation of inflorescence
(iv) end of elongation to emergence (lag)
(v) elongation of flowering stalk

Work on the study of flower development has been mainly concerned with the first three of these phases (Julien[4,5] Coleman[2]). In the 1976 flowering season, a study was made on the rate of elongation of the leaf sheaths during the period between start of elongation and inflorescence emergence to determine the effects of various photoperiod treatments on leaf sheath elongation. The period studied corresponds approximately to phase (iii) and (iv) of MacColl. A study by Nuss and Brett[7] had shown that rate of flower development was influenced by rate of daylength decline and this work was a continuation of that study.

Materials and methods

There were five varieties in each of the six photoperiod treatments (Table 1), and six plants of each variety, each consisting of a single stalk. The varieties were CB 40/35, Co 419, N55/805, NCo 310 and NCo 376. Setts were planted in September, 1975 in bins filled with sand and mounted on trolleys which could be wheeled into and out of the heated photoperiod house or heated glasshouse. A water table was maintained in each bin at 120 mm so plants were always well supplied with water.

Treatments P1-P5, inclusive, were carried out in the heated photoperiod house and treatment P6 in the heated glasshouse. Plants of treatments P4 were always given a natural sunset, while those of P5 were moved into the photoperiod house at 16h30 once daylength had reached 12,0 hours, so that from then on plants in this treatment received an artificial sunset. With treatment P6 the lights were switched on at 05h30 each day, so that daylength decreased in the evening only.

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TABLE 1
Photoperiod treatments (see text for further explanation)

Photoperiod treatment	Starting date	Daylength at start (h)	Rate of decline in daylength	Date on which daylength was 12,5 h
February initiation				
P1	1 Feb	12,50	30 sd^{-1}	1 Feb
P2	1 Feb	12,63	30 sd^{-1}	16 Feb
P3	1 Feb	12,50	Constant	1 Feb
March initiation				
P4	1 Mar	12,75	30 sd^{-1}	30 March
P5	1 Mar	12,75	30 sd^{-1}	30 March
P6	7 Feb	13,32	Artificial dawn 50 sd^{-1}	30 March

At the first sign of leaf sheath elongation (the first external sign of flowering) a label was attached to the lowest sheath showing elongation and the date noted. Weekly measurements of sheath lengths were made, from the labelled sheath upwards, until the flower emerged; leaf sheaths were not measured later. Dates of flower emergence and of anthesis and number of sheaths which had elongated were noted. Rate of elongation was determined by dividing the length of the elongated leaf sheaths by the number of days from the first sign of elongation to flower emergence.

Results

1. *Rate of elongation of leaf sheaths*

(*a*) Lengths of elongated leaf sheaths

Sheath length in treatment P2 was significantly greater than that in treatment P1 (Table 2). The reason for this is not clear since there was little difference between the treatments except for the initially longer day in treatment P2.

Plants in treatments P2 and P3 had significantly longer leaf sheaths than those in treatments P4 and P5, indicating that early initiation causes sheaths to be longer than does late initiation. Ambient temperatures were higher during the growth phase of the early initiation treatments and this may have accelerated elongation. The sheaths of plants in treatment P4 were shorter than those of plants in treatment P5 (not significantly), possibly due to the plants in treatment P4 remaining outside until after sunset (with lower temperatures) during the growth phase of the sheath, while plants in treatment P5 were moved into the heated photoperiod house at 16h30 daily. There was no significant difference between plants in either treatments P4 or P5 and those in treatment P6.

(*b*) Number of elongating leaf sheaths

The plants in treatment P5 had the smallest number of elongating leaf sheaths and this number was significantly less than the numbers in treatments P1 and P2 (Table 2). Early initiation treatments tended to produce plants with more elongating leaf sheaths than did late treatments, again possibly because of higher temperatures during the growth of the sheaths.

TABLE 2
Results of the experiment

Photoperiod treatment	Total length of leaf sheaths m	Number of elongating leaf sheaths	Daily growth of elongating leaf sheaths mm	Number of days from initiation to elongation	Number of days from elongation to flowering	Number of days from initiation to flower emergence
Early initiation						
P1	0,85	4,12	36,8	79	23	102
P2	0,99	4,34	34,0	69	29	98
P3	0,97	4,10	21,2	91	46	137
Late initiation						
P4	0,75	3,84	27,4	62	28	90
P5	0,81	3,44	25,4	63	31	94
P6	0,86	4,06	45,6	39	19	58
L.S.D. (5%)	0,13	0,54	4,5	9,1	6,0	10,1
L.S.D. (1%)	0,18	0,74	6,1	12,4	8,2	13,8

(*c*) Daily leaf sheaths elongation

The rate of sheath elongation in treatment P6 was significantly faster than in the other treatments (Table 2). The daylength decline for treatment P6 was greater than in the other treatments and this was possibly the reason for the faster sheath elongation.

The rates of leaf sheath elongation in treatments P1 and P2, both with 30 seconds per day decline, were similar but they were significantly faster than the rate of elongation in treatment P3, which had a constant daylength. The rate of sheath elongation in treatments P1 and P2 were significantly faster than that in treatments P4 and P5 and this was probably because of lower temperatures during the sheath elongation phase of treatments P4 and P5.

2. *Number of days to flower*

The length of both the period from initiation to elongation and of that from elongation to flower emergence differed significantly between treatments P1 and P2 (Table 2). This indicates that a difference of only sixteen days in the date of initiation can affect the growth of the flower initial. The number of days in the two periods for treatments P1 and P2 were significantly less than those for treatment P3. The highest number of days from initiation to emergence was in treatment P3. In the late initiation treatments, the differences between treatments P4 and P6, and between treatments P5 and P6 were significant. Treatment P6 gave the smallest number of days for both periods of all treatments.

There was little evidence to show that any of the treatments had an effect on the number of days from flower emergence to anthesis.

Discussion

The main feature of the results of this study was the difference in rate of leaf sheath elongation when daylength was constant and when daylength declined rapidly. It is nevertheless important to separate those results which can be attributed to temperature and those which are clearly the result of photoperiod.

The plants in the constant daylength initiated early in February when temperatures were higher than later in the season and yet the sheaths of plants in this treatment showed a slower elongation rate than that of plants in all the other treatments. This would therefore seem to be the result of photoperiod. James and Miller[3] also found that a 12,5 h constant daylength delayed flowering when compared with a declining daylength. The photoperiod effect is also evident with treatment P6, in which the sheaths had the fastest elongation rate, despite the fact that initiation took place later when daytime temperatures were lower. Nuss and Brett[7] found that a 50 s/d decline produced early flowering.

The longer and the greater number of leaf sheaths nodes found with the early initiation treatments, P1 and P2, were probably the result of temperature because the plants in these treatments initiated two months earlier than did the plants in the late initiation treatments (P4 and P5), so benefiting from higher temperatures. These two groups of treatments had the same daylength decline. Higher temperatures were also the most likely reason for the faster elongation rate of leaf sheaths in treatments P1 and P2 compared with those in treatments P4 and P5.

The length of the sheaths produced was similar with both fast and slow declines in daylength. However, a fast decline shortened both the phase from initiation to elongation and that from elongation to flower emergence, so the similar total length was the result of a faster daily elongation rate in the fast declining daylength.

MacColl,[6] working in Barbados, found that the number of days from initiation to emergence tended to be greater in clones that initiated early, than in those that initiated late. The same result was observed here with all of the five varieties tested, although differences were not always statistically significant. Using only one variety in a declining daylength (decline per day not given), he observed a period of fifty eight days from initiation to flowering similar to the result found here in treatment P6.

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