Further Studies on the Role of Leaves in Sugarcane Flowering[1]

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INTRODUCTION

Previous reports (1,4) have shown that in sugarcane the leaf spindle has an essential and dominant role in the production of the flowering stimulus. Recent work in Puerto Rico by Chu and Serapión (2) has further demonstrated that within the leaf spindle the expanding leaves or the leaves just fully expanded (−1 in the variety N.Co. 310 and 0 in variety P.R. 980) appear to be most effective in producing a flowering stimulus. Moreover, in contrast to this, the mature leaves (0, +1, +2) in the N.Co. 310 apparently produce a transmissible inhibitor to prevent flowering. However, Julien (5) concluded from his work in Mauritius that the removal of leaf +1, leaf +2, or the spindle delayed flowering while the removal of mature leaves (+3 and +4) hastened flowering in U.S. 48-34. From his studies on the photoperiodic control of flowering Julien (6) again reported that the presence of the leaf spindle, leaf +1 and leaf +2 was necessary for the promotive effects of photoperiod at all stages from induction to the early part of elongation of the inflorescence.

The present experiments were undertaken to determine: a) Whether the same leaf ranks of different varieties experience a common pattern in their role of photoperiod perception and flowering stimulus; b) the relative importance of young leaves at different stages of inflorescence development; and c) whether all varieties react to the same length of day.

MATERIALS AND METHODS

Three foliar trimming experiments were conducted during the years 1970 through 1972 at the Agricultural Experiment Substation, Gurabo, Puerto Rico. The varieties N.Co. 310, P.R. 980 and Cl 41-223 were established in the field and managed in like manner as reported previously (2). A randomized block design with variable numbers of replicates was adopted for all. Pertinent information for the experiments is summarized in table 1

Tassel counts were made at 5-day intervals in Experiments I and III

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TABLE 1.—*Summary of materials and methods employed in three foliar trimming experiments*

Experiment	Variety	Treatment (leaf rank removed)[1]	Date of removal	Number of replicates	Number of plants per treatment
I	P.R. 980	−1, 0	Sept. 2, 1971	4	16
		+1, +2			
		+3, +4			
		Control	None		
	Cl 41-223	−1, 0	Sept. 14, 1971	4	16
		+1, +2			
		+3, +4			
		Control	None		
II		0, −1, −2[2]	(A) Aug. 28, 1972	8	24
			(B) Sept. 11, 1972		
			(C) Sept. 18, 1972		
		Control	(D) None		
	Cl 41-223	0, −1, −2[2]	(A) Sept. 18, 1972	6	12
			(B) Oct. 11, 1972		
			(C) Nov. 1, 1972		
		Control	(D) None		
III	Cl 41-223	Leaf spindle[3]	At weekly intervals beginning July 18 and ending Oct. 10, 1970 and 1972	1	4
		All leaves except leaf spindle			
		Control	None		

[1] The leaf having the highest visible dewlap is designated as leaf +1.
[2] Including all the younger leaves rolled within leaf −2.
[3] Including leaves +1 and younger.

and at 3-day intervals in Experiment II, beginning when the first emerging inflorescence was visible. Stalks failing to produce an inflorescence were dissected at the end of January or early in February and the flowering status was recorded. The percentages for floral initiation and emerged tassels in Experiments I and II were calculated and subsequently transformed into angles for statistical analyses in accordance with Snedecor (7).

RESULTS

EXPERIMENT I

The effects of two consecutive leaf-trimmings on the percentages of floral initiation and emerged inflorescence are presented in figures 1 and 2. As

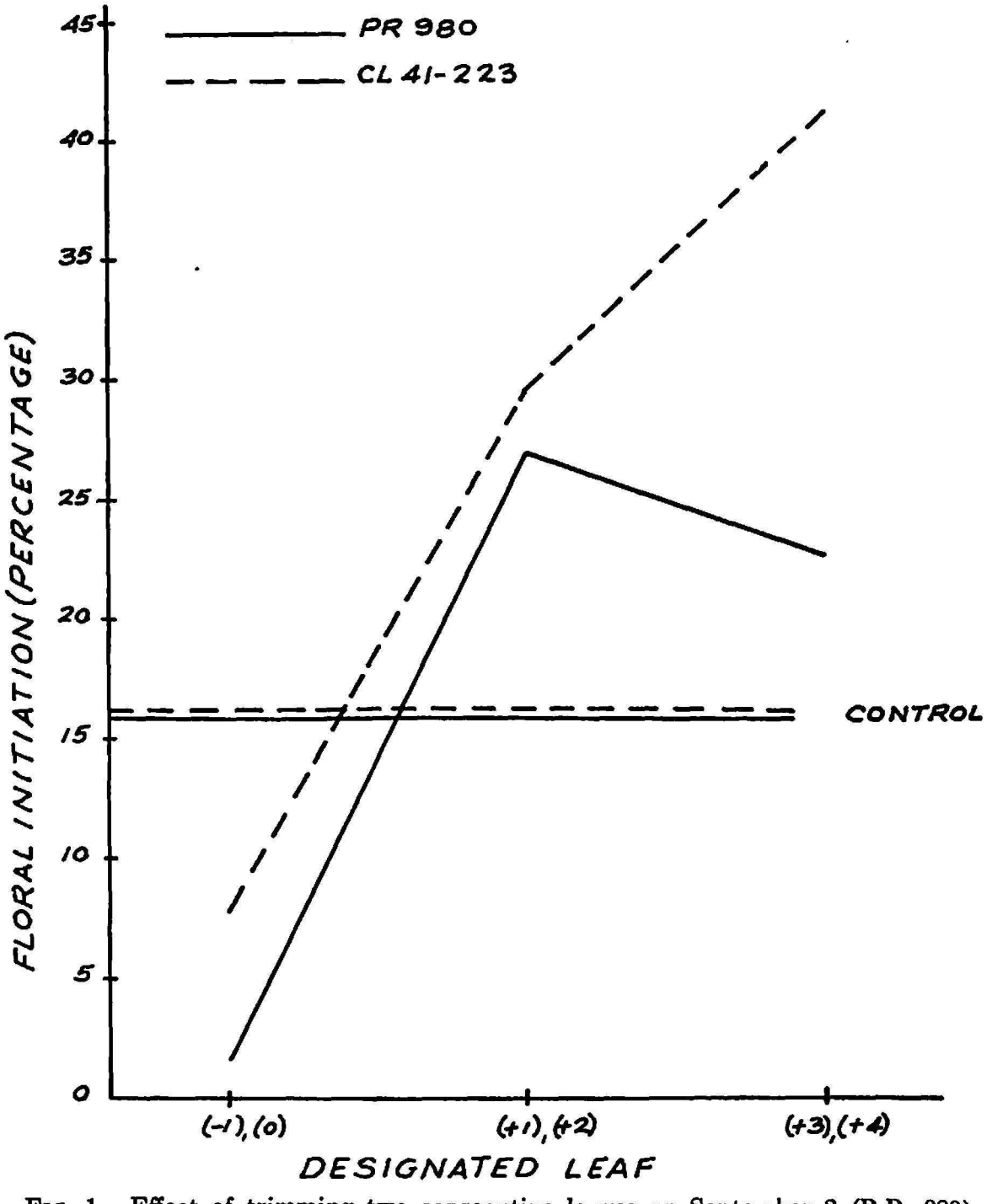

FIG. 1.—Effect of trimming two consecutive leaves on September 2 (P.R. 980) and September 14 (Cl 41-223) on the percentage of floral initiation in 1971.

shown in figure 1, the removal of leaves −1 and 0 on September 2 resulted in a markedly lower initiation intensity in the variety P.R. 980. This response was significant at the 1-percent level. Removal on the same day of leaves +1 and +2, and of +3 and +4 somewhat enhanced floral initiation, though both effects were not statistically significant.

For the variety Cl 41-223 the removal of leaves +3 and +4 on Septem-

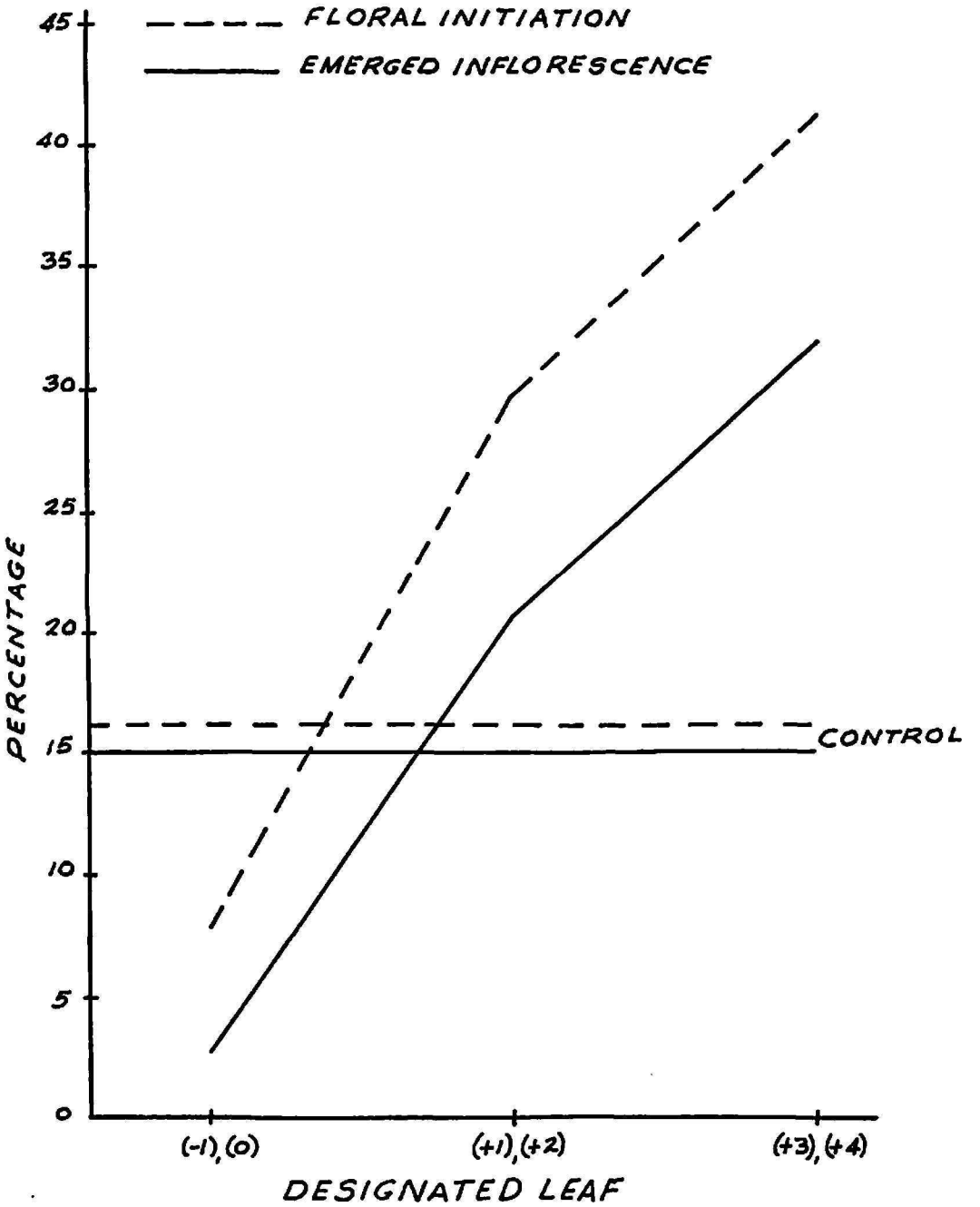

FIG. 2.—Effect of trimming two consecutive leaves on September 14 (Cl 41-223) on the percentages of floral initiation and emerged inflorescence in 1971.

ber 14 induced a higher percentage of floral initiation (fig. 1). This effect was significant at the 5-percent level. A somewhat similar flowering pattern resulted with P.R. 980 from trimming leaves −1 and 0, and +1 and +2 though both effects were not statistically significant.

With reference to tassel emergence the effects of foliar trimming were essentially similar to those on floral initiation (fig. 2), although none of the differences were statistically significant.

EXPERIMENT II

Based on different stages of floral development, leaves 0 to −2 were trimmed from N.Co. 310 and Cl 41-223 in four treatments (table 1).

Flowering response to treatments are presented in figures 3, 4 and 5. As shown in figures 3 and 4, treatment A, trimming leaves 1 to 2 weeks prior to primordia initiation, resulted in a substantial reduction in the intensity of both floral initiation and tassel emergence in both varieties. The effects were significant at the 1-percent level relative to all other treatments. Treatment C, elongation in secondary branches in N.Co. 310 (fig. 3) also produced somewhat depressive responses in both floral initiation and tassel emergence. Both effects were significant at the 5-percent level as compared with control plants. None of the differences between any other two treatments were statistically significant.

Flowering time was substantially delayed as a result of the early removal of leaves 0 to −2 in N.Co. 310 (fig. 5). During the 12-day period beginning October 26 and ending November 6, 326 tassels (91.1 percent) were recorded from control plants, whereas only 26 tassels (25.2 percent) emerged in treatment A. On the contrary, 47 tassels (45.6 percent) appeared in treatment A during the 24-day period from November 7 to 30, the flowering season for a majority of breeding canes in Puerto Rico (3). Meanwhile, only 17 tassels (4.7 percent) were recorded in control plants for this period. The number of tassels found in treatments B and C were 174 (57.8 percent) and 155 (56.4 percent), respectively, during the first 12-day period, and 69 (22.9 percent) and 66 (23.9 percent) during the next 24-day period. The numbers of tassels having potential emergence after December 25 were 19, 48, 42 and 8 for treatments A, B, C, and control, respectively.

EXPERIMENT III

Flowering response to spindle- and leaf-trimming are presented in figures 6 and 7. Spindle removal once on August 29 or at any date in September reduced significantly both floral initiation and tassel emergence in the variety Cl 41-223. Conversely, spindle trimming once at various dates prior to August 15 appeared to enhance the intensity of both initiation and tassel emergence.

Leaf removal also caused depressive responses when the leaves were trimmed away once at various dates in September. However, these changes were of a lesser magnitude than those due to spindle trimming. Leaf-trimming once prior to September 5 caused a marked increase in either floral initiation or tassel emergence. This treatment had no effect on floral initiation when the leaf was cut once either before August 1 or after October 3.

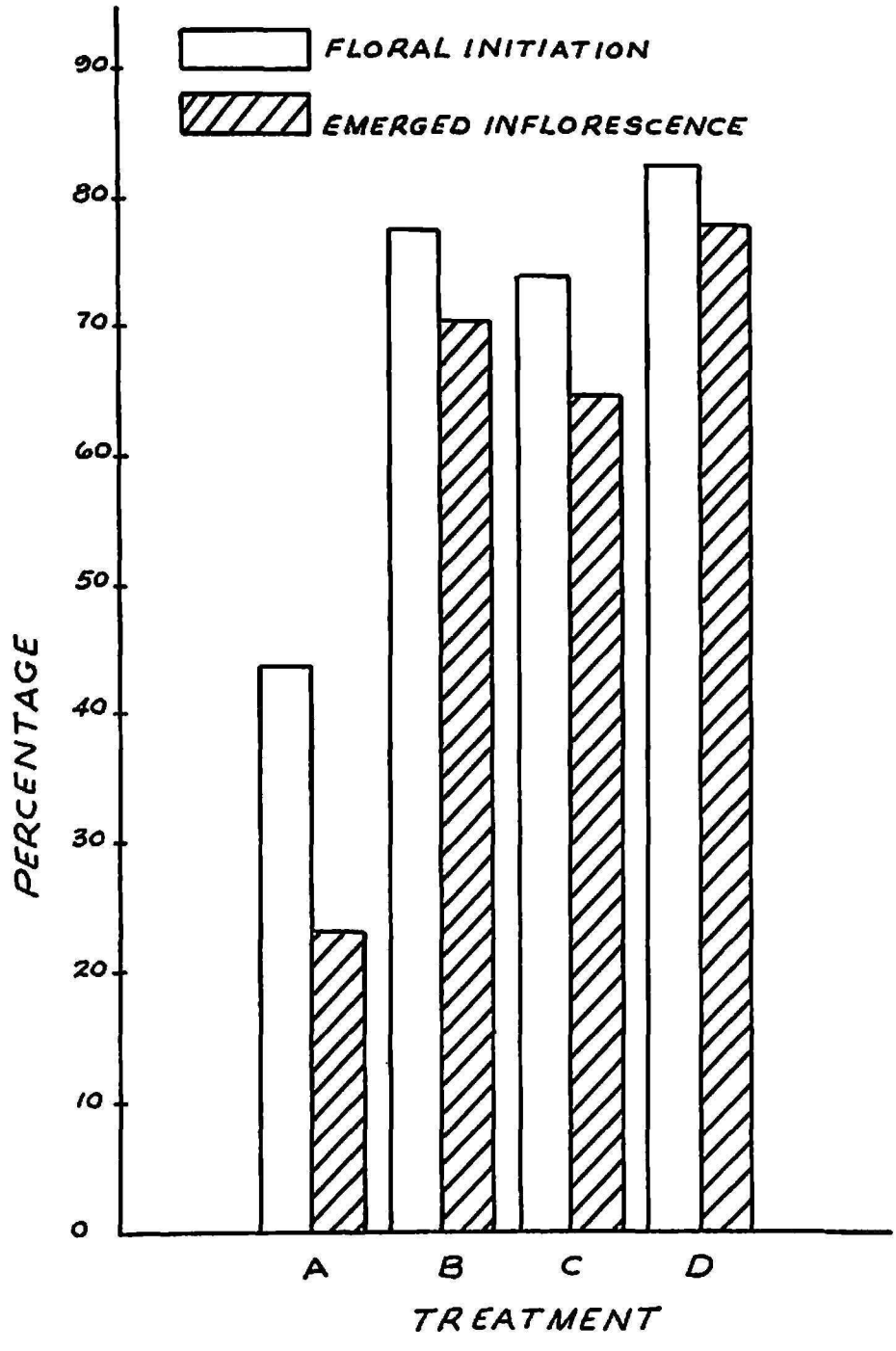

FIG. 3.—Effect of trimming leaves 0 to −2 on the percentages of floral initiation and emerged inflorescence in four treatments (N.Co. 310): (A) On August 28, about 1 week prior to initiation; (B) on September 11, stages of primordia initatiion and primordia branch elongation; (C) on September 18, stage of primordia elongation of secondary branches; and (D) a control treatment consisting of no leaf removal in 1972.

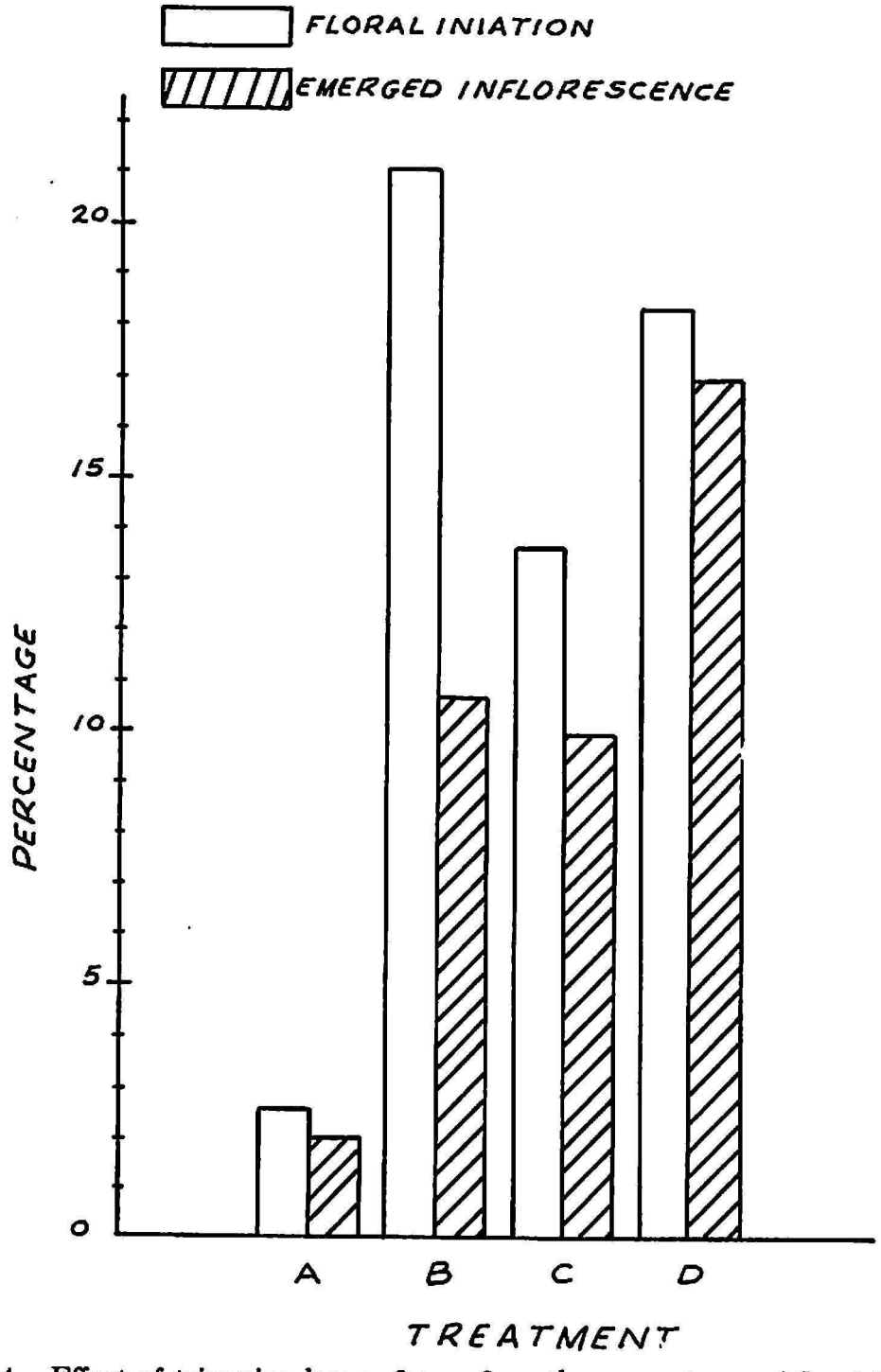

FIG. 4.—Effect of trimming leaves 0 to −2 on the percentages of floral initiation and emerged inflorescence in 4 treatments (Cl 41-223): (A) On September 18, about 2 weeks prior to initiation; (B) on October 11, stages of primordia initiation and primordia branch elongation; (C) on November 1, stage of initiation of spikelet primordia; and (D) a control treatment consisting of no leaf removal in 1972.

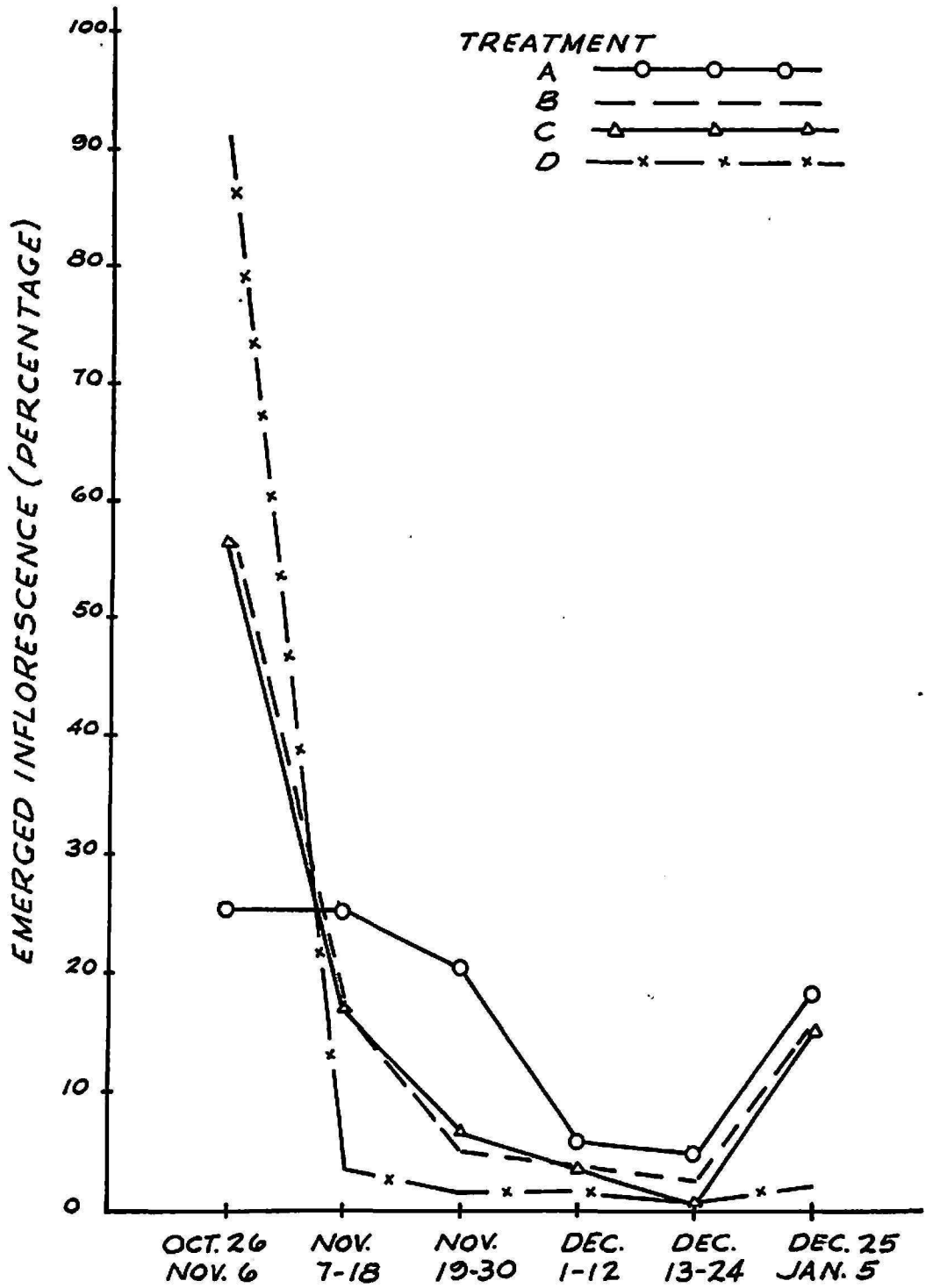

FIG. 5.—Effect of trimming leaves 0 to −2 on the number of tassels emerging per 12-day class interval expressed as a percentage on the total number of emerged tassels in four treatments (NCo 310): (A) On August 28, about 1 week prior to initiation; (B) on September 11, stages of primordia initiation and primordia branch elongation; (C) on September 18, stage of primordia elongation of secondary branches; and (D) a control treatment consisting of no leaf removal in 1972.

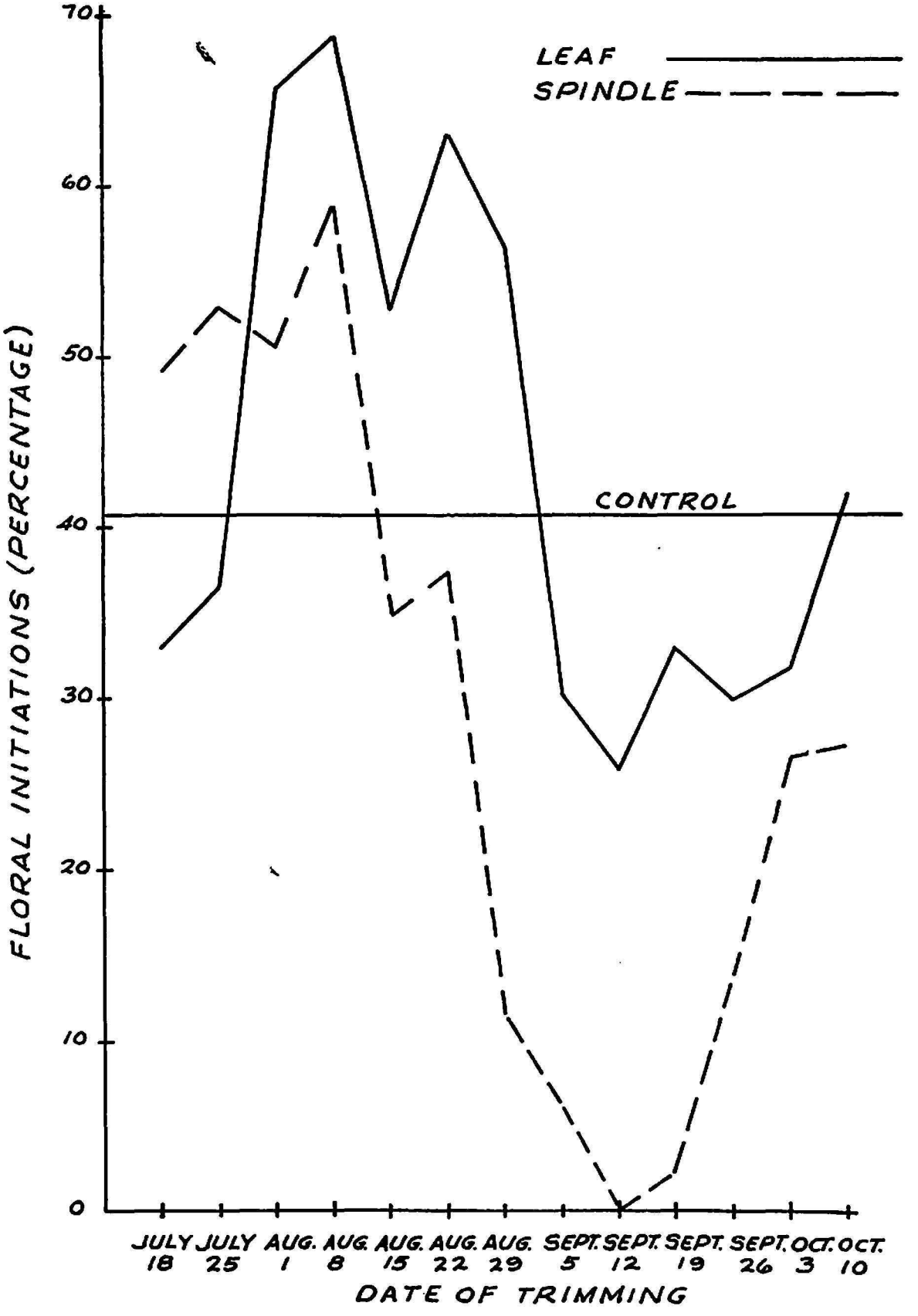

FIG. 6.—Effect of trimming the leaf spindle or all leaves except the leaf spindle once on various dates, on the percentage of floral initiation in variety Cl 41-223 in 1970 and 1972.

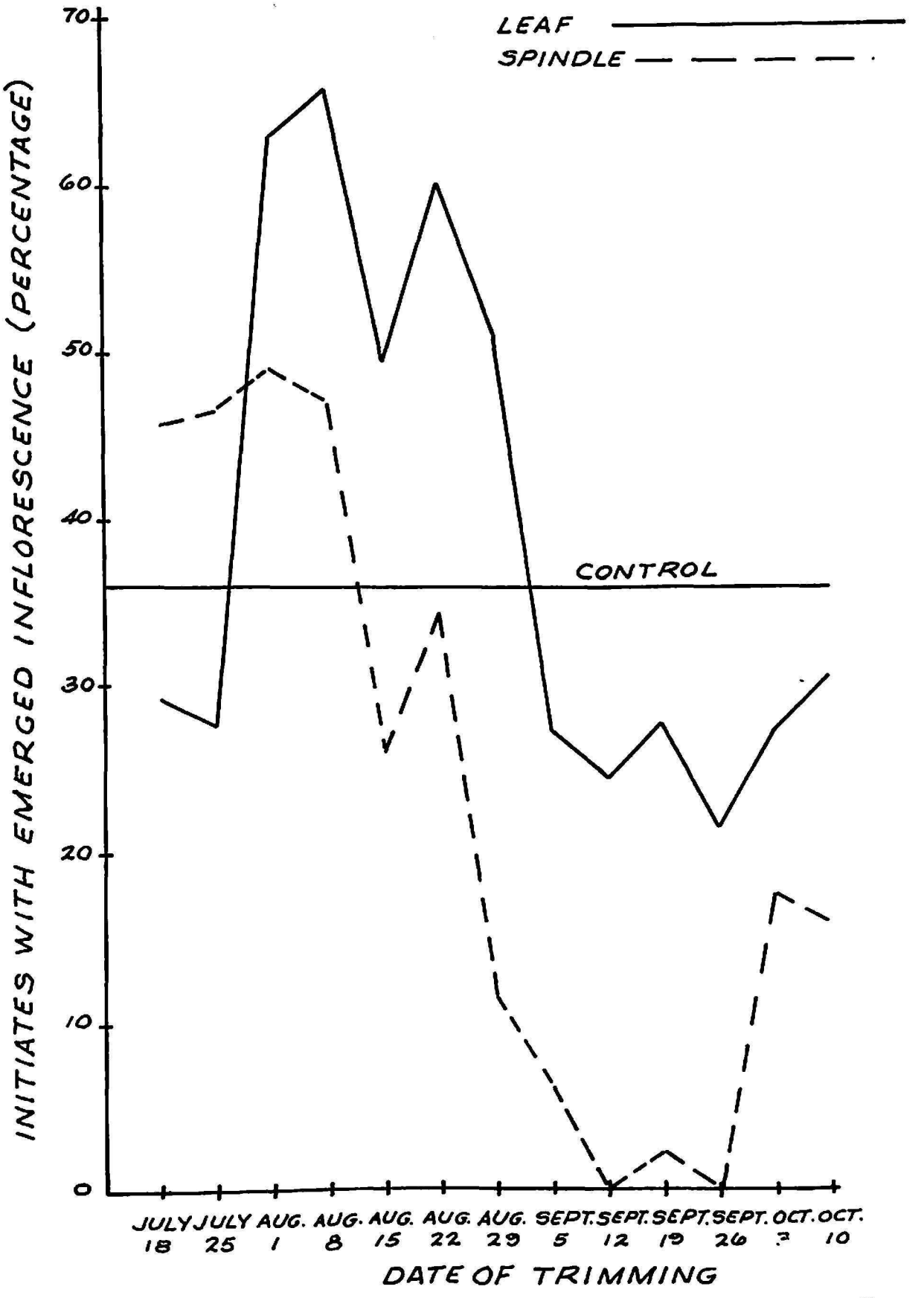

FIG. 7.—Effect of trimming the leaf spindle or all leaves except the leaf spindle once on various dates, on the percentage of emerged inflorescence in variety Cl 41-223 in 1970 and 1972.

DISCUSSION

The present results are in close agreement with earlier findings (2) showing young expanding leaves to be the most effective in inducing flowering stimulus.

With increasing age there appears to be a gradually diminishing photoinductive sensitivity of sugarcane leaves. This view is supported by the substantial loss of flowering intensity through spindle trimming (in Cl 41-223) and of reduced flowering depression by removal of mature leaves (1). On the other hand, the ability to produce a flowering inhibitor appears to increase with advancing leaf age. This assumption is supported by the enhanced flowering response to spindle trimming (figs. 6 and 7) and the remarkably higher flowering intensity as a result of removing the mature and old leaves in Cl 41-223.

Somewhat different effects induced by removing the same leaf ranks from different varieties were probably due to the different leaf patterns of the varieties involved. Observations made at the time of defoliation and thereafter revealed that the number of the active leaves present on the plant varied considerably among varieties. It was thought that leaf +6 of most Cl 41-223 plants was still active as evidenced by its color and clinging leaf sheath. Conversely, a majority of leaf ranks +6 and +5 were no longer attached on P.R. 980. Similarly, nearly all −2 leaves in Cl 41-223 were partially expanded while the same rank was still tightly rolled in P.R. 980. These facts suggest that the same leaf ranks of different varieties bear distinct physiological ages which in turn may relate to their performance in producing a flowering stimulus or inhibitor.

It is evident that the inhibitory effect on flowering was still present though less marked when leaves, 0, −1 and −2 were removed during the latter stages of inflorescence development (fig. 5). This was reflected in a considerable delay of flowering time in the variety N.Co. 310. It is suggested that defoliation of young expanding leaves could be developed into a practical and effective measure for the manipulation of flowering time of breeding material.

It is of interest to note that whereas both floral initiation and emerged tassels increased as a result of spindle removal before August 8, they declined slightly when the spindle was trimmed on August 15 or August 22, and a marked decline followed spindle removal on August 29 and thereafter (figs. 6 and 7). The spindle leaf of Cl 41-223 appears to commence responding to day length and producing a flowering stimulus around August 20. This suggests that a late-initiating variety such as Cl 41-223 (3) may begin an initial response to photoperiod about 2 to 3 weeks later than an early-initiating variety such as N.Co. 310 (1). The number of inductive days required for flower initiation in Cl 41-223 appears to be 42 (3). Of

interest also is the fact that spindle removal prior to the differentiation period also tends to produce a stronger flowering stimulus, as in the case of leaf removal, though to a lesser degree. Presumably, both the young spindle and mature leaves may produce a growth-promoting and flower-inhibiting substance before commencing to react to the day length needed to produce a flowering stimulus.

SUMMARY

The role played by leaves in the perception and inhibition of the flowering stimulus was studied through defoliation treatment in three sugarcane varieties. It was found that the expanding leaves (0 and −1) in the variety P.R. 980 appear to be most effective in producing a flowering stimulus. The mature leaves (+3 and +4) in the variety Cl 41-223 appear to produce a transmissible flowering inhibitor. Absence of the young leaves within the leaf spindle during a period critical to initiation of inflorescence primordia resulted in a significant reduction of flowering intensity in varieties N.Co. 310 and Cl 41-223, and a marked delay in the flowering time in N.Co. 310. Removal of these leaves during subsequent stages of inflorescence caused a somewhat depressive flowering response and a considerable delay in the flowering time of N.Co. 310. A late-initiating variety, Cl 41-223 appears to begin producing a floral stimulus around August 20, about 2 to 3 weeks later than that of the early-initiating variety N.Co. 310.

RESUMEN

En este trabajo se estudia el papel que desempeña la remoción de distintas hojas en tres variedades de caña en la percepción e inhibición del estímulo floral. Se observó que en la variedad P.R. 980 las hojas a punto de abrir (0 y −1) son las que más efectivamente inducen estímulos florales. En la variedad Cl 41-223 las hojas maduras (+3 y +4) aparentemente elaboran alguna substancia transmisible que inhibe la floración. La remoción de las hojas nuevas del cogollo en las variedades N.Co. 310 y Cl 41-223 durante el momento crítico de la inducción redujo significativamente la intensidad de la floración en ambas y causó un retraso significativo en la emergencia de la panoja en la N.Co. 310. Las defoliaciones realizadas durante el transcurso de las diferentes etapas de desarrollo de la inflorencencia en la N.Co. 310 disminuyeron la intensidad y causaron una demora en la emergencia de la panoja. La Cl 41-223, de iniciación tardía, aparenta iniciar el estímulo floral alrededor de agosto 20, ó sea, 2 ó 3 semanas después que la N.Co. 310, que es temprana.

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