LEAF SHEATHS AND THE INHIBITION OF GERMINATION OF YOUNG AXILLARY BUDS IN SUGARCANE[(1),(2)]

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ABSTRACT

The younger parts of field-grown stalks of the sugarcane variety Co 205, with spindle included but with leaf blades trimmed back, were grown in distilled water in the dark. When sheaths were left intact, few buds germinated; axillary shoots developed only from mature nodes. When sheaths were removed, many more buds germinated; axillary shoots developed from both older immature and mature nodes. The results, applied to normal stalk development, suggest that the sheath helps to control tillering. Germination of young buds could be inhibited by the sheath when the sheath is tight as around upper cylindrical nodes, but not when the sheath is loose as around lower obconic nodes at the base of the stalk.

INTRODUCTION

Sugarcane differs from many other grasses in the prolonged period of vegetative growth of the individual stalk. New stalks are added to the stool of cane by the growth of axillary shoots or tillers which develop early in the life of a stalk. Unless injured, diseased, or flowering, no further axillary shoots develop from a cane stalk, even though the stalk may continue to grow for many months and even though each of the many new nodes formed will have a bud.

Barber[1] summarized the growth pattern of sugarcane stalks within a stool in these words: "...when we consider each shoot separately, we see that there are two very distinct periods of growth in it, the first answering closely to the tillering period, when it is increasing in thickness and length of joint and is busy in forming its branches, and the second, when, after attaining its full thickness, it commences to form joints of appreciable length, and rapidly shoots into the air, a stage comparable with the elongating period in grasses. Thus the periods which characterize the shoots of the grass plant at one and the same time are present in the cane plant also, but

(1) A contribution from ARS, USDA in cooperation with the Louisiana Agricultural Experiment Station.

(2) Portions of this paper have been presented at the annual meetings of the American Society of Sugar Cane Technologists, 1973, and the American Society of Plant Physiologists, 1976.

in each shoot independently of the others." This pattern of growth occurs whenever moisture, temperature, and soil fertility permit.

All the undamaged buds of the entire cane stalk are capable of developing into axillary shoots. When a stalk is planted as seed cane, the buds at the youngest and oldest ends germinate preferentially. When the stalk is divided into one-node seed pieces before planting, however, the rate of germination of the buds follows a gradient in which the youngest buds germinate most quickly and the oldest, most slowly.

In the growing stalk, young axillary buds germinate in the first period of growth and are inhibited in the second period. This inhibition is determined within the individual stalk and not by the plant because a single stool may have stalks simultaneously in the two different periods of growth.[1] Within a single stalk, the sharp discontinuity in bud development between the periods of growth, essentially from no apparent apical dominance to complete apical dominance, suggests that some other factor(s) must change concomitantly.

Environmental factors could modify the hormonal and competitional effects of apical dominance. Tillering usually occurs when the stalk grows from the soil to the air environment. This change from soil to air introduces new variations in light, moisture, and temperature. That these factors are not directly involved in tillering may be shown by the aerial development of entire stools on uprights.[2] Here the stool often produces a vigorous main shoot with axillary shoots developing in the first period of growth, showing that environmental factors associated with emergence are not directly responsible for tillering in the first period.

For the young buds in the first period of growth, the sheath of the older node is pushed aside by the widening of the next younger node. For the young bud in the second period, on the contrary, the next younger node is no larger than the adjacent older node, so the sheath remains tightly appressed over the young bud.

If the sheath inhibits the growth of the young bud, as in seed pieces[3,4], removal of the sheaths from the younger nodes in the second period of growth should cause the buds to germinate. This hypothesis was tested in experiments in which the detached tops were grown after some or none of the sheaths had been removed. In these experiments, detached tops were placed in the dark where the supply of stored nutrients would limit growth and development, and detached tops were used rather than intact plants to eliminate the effects of competition among shoots.

MATERIALS AND METHODS

The experiments were performed once each year for 4 years with detached tops of the variety Co 205 (*Saccharum officinarum* x *S. sponta-*

neum). Tops of this variety were used because they grew rapidly in the dark and died rapidly. The cane was field-grown and harvested for three experiments in November and for one experiment in early September (before the onset of the presumed inductive photoperiods under Louisiana conditions). Plant cane was used in two experiments, and ratoon cane was used in two experiments. Cane infected with ratoon stunting disease was used in one experiment. In the other experiments, the cane was derived from heat-treated cane and was presumed to be healthy. The harvested stalks were carefully examined, and any stalk showing external evidence of floral initiation or of sugarcane borer infestation was rejected.

The detached tops were prepared uniformly by cutting through the stalk 2.5 cm below the node which carries the eighth youngest leaf with dewlap exposed (node 8) and by removing the entire leaves and buds from this node and the next younger node (node 7). The spindle leaves and the leaf blade of leaf 1 were trimmed 5 to 8 cm beyond its dewlap. The intermediate leaves had the leaf blades cut closer to the dewlap. The tops were randomly assigned to treatments, ten tops per treatment.

All experiments had three treatments in common, namely, the tops with no more sheaths removed (the controls), the tops with two sheaths removed (from nodes 5 and 6), and the tops with four sheaths removed (from nodes 3 to 6). A fourth treatment, removal of the sheath of node 6 only, was included in one experiment, and the number of controls was doubled in another.

The tops were placed in tumblers with sufficient distilled water to cover node 8. The tops were supported in an upright position by nylon netting. The tops were in darkness except for brief periods of observation. The temperature was generally between 20° and 30 C, with occasional dips to 10 C.

The readings for germination of axillary buds were made after all the tops were apparently dead. In the first experiment, after 70 days, a few buds still appeared to be viable. In the other experiments, after 7 to 12 months, the tops were dried out. The reading was delayed until this point to avoid apparent differences in germination due to differences in germination rate.

When the experiment was terminated, the sheaths were carefully removed so as not to damage the shoots which had developed between sheath and stalk. An axillary shoot was considered to be present when the prophyll was clearly open and the young shoot protruded. The numbers assigned to leaves and nodes at the time of preparation were used throughout the experiment to record all data. Tops which had borer damage previously hidden by the sheaths were discarded.

RESULTS AND DISCUSSION

The detached tops grew during the period of darkness, and the growth included the rooting of all tops from node 8, the elongation of leaf sheaths and blades, the elongation of young stem internodes, and the development of axillary shoots. Within each treatment, there was a wide range in the distribution and extent of growth.

At the time of preparation, the internode of node 3 was usually not fully elongated and was soft; the internode of node 4 was fully elongated but still soft; internodes 5 and 6 were mature. The buds that germinated were from node 3 or older, and no buds germinated from the sheathed nodes of node 2 or younger, even though these were undisturbed in all treatments.

TABLE I. The effect of sheath removal on axillary shoot growth of detached sugarcane tops of Co 205. (Sum of 4 experiments).

Sheath removed (node)	Number of tops	Axillary shoots from node 3	4	5	6
—	49	0	0	3	3
6	10	0	0	1	4
5, 6	38	1	0	23	17
3, 4, 5, 6	38	16	25	28	18

In all 4 years, germination was inhibited when the nodes were sheathed, and germination was favored when the sheaths were removed (Table I). When the sheaths were removed from nodes 3 to 6, the buds of nodes 4 and 5 germinated more frequently than those of nodes 3 and 6 (significant χ^2 test). A bud position on the stalk favorable for germination has been noted by Mitchell.[5]

In the field, on nodes older than those used in these experiments, the sheaths loosen naturally, yet the buds do not germinate. In one-node cuttings the older buds germinate less readily, and Mitchell's observation on ryegrass may apply, that the longer a bud has been inhibited, the more difficult it is to stimulate it to resume growth later. Competition from tillers already growing apparently inhibits germination, and these factors may contribute to apical dominance when the sheath is no longer present.

In summary, the germination of buds on sheathless nodes in the dark shows that the presence of the sheath around buds of nodes 3 to 6 acts as an inhibitor of germination. The results support the hypothesis that when these young sheaths are pushed aside, as they would be by thickening nodes, tillering occurs.

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LAS VAINAS FOLIARES Y LA INHIBICION DE LA GERMINACION DE JOVENES YEMAS AXILARES EN LA CAÑA DE AZUCAR.

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RESUMEN

Las partes más jóvenes de tallos extraídos del campo, de la variedad Co 205, con el broteguía incluído pero con las láminas foliares podadas, estuvieron creciendo en agua destilada en la oscuridad.

Donde las vainas quedaron intactas, germinaron pocas yemas y los brotes axilares se desarrollaron solamente desde los nudos maduros.

Cuando las vainas fueron removidas, germinaron muchas más yemas; aquí los brotes axilares se desarrollaron tanto de nudos viejos inmaduros como de nudos maduros. Estos resultados aplicados al desarrollo de un tallo normal, sugieren que las vainas ayudan a controlar el macollaje. La germinación de yemas jóvenes podría ser inhibida por las vainas cuando estas vainas están apretadas alrededor de los nudos cilíndricos superiores, pero no cuando las vainas están desprendidas alrededor de los nudos obcónicos inferiores en la base del tallo.