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BRIEF COMMUNICATION

Bud Breaking and Adventitious Root Formation in *Panicum maximum* JACQ.

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Abstract. When stem cuttings were put in water the dormancy of the bud was broken. No inhibitory substances could be found in the leaves and no effect of exogenous growth substances could be detected. Dormancy of buds in the present case seems to be the result of the mechanical resistance imposed by the leaf sheath upon the bud.

Gibberellic acid was very effective in promoting root formation in the woody stem cutting of *Panicum maximum* and the present results point to a direct effect on root initiation by gibberellic acid.

The dormant state is associated with an inability to grow and a very low respiration rate (POLLOCK 1960). In temperate plants, buds come out of dormancy through an effect of low temperature (DARROW 1942) or long photoperiods (WAREING 1953). Because of many data like these the dormant state is supposed to be regulated by external factors, which will act upon the endogenous growth substances (VEGIS 1964).

Gibberellic acid has been shown to inhibit or to have no effect on root formation in stem cuttings. According to BRIAN *et al.* (1960) the role of GA in the inhibition of rooting is to prevent the early cell divisions leading to the establishment of a root primordium.

P. maximum is a short day plant for flowering with a critical photoperiod of between 12 and 14 h (FELIPPE 1978). It has been shown that when the main axis is in flower the five axillary buds nearer the apex are floral buds and non-dormant, but the lower buds (from 6 downwards) are dormant and vegetative (FELIPPE 1979).

This study shows some results for bud breaking and adventitious root formation in *P. maximum*.

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MATERIAL AND METHODS

The main axis of *Panicum maximum* JACQ. has at each node a dormant bud. In the experiments reported here only stem cuttings from the middle part of the main axis were used (nodes 7 and 8 from the top). The plants were growing in the field and were around 2 m high. The cutting included the node (about 1.5 cm diameter) and dormant bud, and 1.5 cm of the internode below the node and 4 cm of the internode above. Prior to treatment the leaf sheath was removed. Adventitious roots, when formed, appear in the middle region of the node, under the bud. The results were observed 5 days from the beginning of the treatments.

The cuttings (4 per bottle) were placed in 150 ml cylindrical bottles, with the lower internode immersed to a constant depth in 20 ml of distilled water or the desired solution. The bottles were placed (without cover) in a plastic box layered with cotton wool moistened with water. The boxes were tightly closed with a transparent lid and kept at 25 °C in a photoperiod of 16 h in a growth cabinet. In general 40 cuttings were used in each treatment.

The growth regulators and substances used were: gibberellic acid (GA_3, Sigma), indolyl-3-acetic acid (IAA, Merck) and 2-dichloroethylphosphonic acid (Ethrel, Amchem). Cuttings with dormant bud and with the buds removed were tested with GA_3. Extract of whole leaves of *P. maximum* was tested. The material was extracted in 80% methanol, which was then evaporated. The crude extract had a final concentration of 900 mg ml^{-1}. Two dilutions were also used: 90 and 9 mg ml^{-1}. In another series of experiments the buds (including node and upper internode) were covered with lanolin or immersed in liquid paraffin with 56 °C fusion point. The cuttings were put in water in the normal way when the paraffin was solid.

Intact plants (vegetative or flowering) were also used, but only the buds in the lower part of the main axis were observed. In one experiment the main apex (vegetative or floral) was removed. In another several treatments were made and they are explained in Table 1. The experiments lasted for 11 days.

RESULTS AND DISCUSSION

1. Bud Breaking

The plants used were growing in the field and the more basal axillary buds were dormant. The external factors causing or breaking dormancy (VEGIS 1964) can be discarded here, because the conditions were the same, but in some plants the dormancy had been broken. Removal of the main apex or the apical inflorescence had no effect on breaking dormancy of these buds, thus their growth was not suspended because of apical dominance.

When stem cuttings were used, the buds came out of dormancy as soon as their bases were put into water. All growth regulators had the same effect as water, and even abscisic acid had no effect, the dormancy was always broken. Leaf extracts had no inhibitory effect — the dormancy was broken. Thus, growth substances do not seem to be involved either as inhibitors or promoters, though these substances have always been associated with bud breaking (VEGIS 1964, VILLIERS 1975). Also, dormancy was broken when the buds were covered with lanolin or paraffin, thus the dormancy was not caused by the leaf sheath being impermeable to gases.

Using intact plants an experiment was carried out with the following treatments: I) intact main axes; II) intact main axes but with the whole leaf (lamina plus sheath) removed; III) intact main axes, but with the laminas of the leaves removed (leaf sheath intact); IV) intact main axes, but with a window cut with a razor blade in the leaf sheath exposing only

TABLE 1
Bud breaking in the main axis of *P. maximum*. Results presented as percentage

Treatments	Developed buds
I. Intact axes	0
II. Whole leaves removed	100
III. Leaf lamina removed	0
IV. Window in leaf sheath	100

the dormant bud. The results can be seen in Table 1, and it seems that bud dormancy here is a direct effect of the leaf sheath. Thus, the data available until now point to a mechanical resistance of the sheath imposed on the growth of the buds. It seems to be the same type of dormancy presented by certain embryos, like that of *Rapanea guianensis*, a tropical plant in which the embryo cannot grow because of the mechanical resistance imposed by the endocarp of the fruit (JOLY and FELIPPE 1979).

2. Adventitious Root Formation

As said before buds always developed when the stem cuttings were immersed in water or in growth regulator solutions. But, in general, there was no formation of adventitious roots in the nodes (carrying the buds) which were immersed in water. When the stem cuttings were immersed in IAA and ethrel the formation of roots was promoted. These results were expected since the promotive effect of auxins and ethylene on adventitious root initiation has been known for some time (ABELES 1973). Gibberellic acid

TABLE 2
Effect of GA_3 on adventitious roots formation. In some cases the axillary bud was removed. Number of cuttings with roots presented as percentage

GA_3 concentration	Bud	[%]
0	with bud	0.0
	bud removed	2.5
3.0×10^{-5} M	with bud	53.3
7.5×10^{-5} M	with bud	62.5
	bud removed	63.7
1.5×10^{-4} M	with bud	56.2
	bud removed	68.7
3.0×10^{-4} M	with bud	50.0
7.5×10^{-4} M	with bud	60.0
1.5×10^{-3} M	with bud	66.6
3.0×10^{-3} M	with bud	73.3

was tested in several experiments and the results of one of these is shown in Table 2.

It can be seen that GA_3 strongly promoted the development of roots in the nodes. The promotive effect was seen every time GA_3 was tested. In some cases the axillary buds were removed to see if the effect of GA_3 was dependent on the presence of the bud (see Table 2). The results suggest no effect of the bud. These results clearly show the promotive effect on rooting of GA_3 when applied alone to the woody stem cuttings of *P. maximum*. The only example of GA_3 alone promoting rooting in a woody stem is that of *Ipomoea fistulosa* (ANAND *et al.* 1972, NANDA *et al.* 1972), but in this case GA_3 only increased the number of roots formed per cutting in relation to the water control. Also according to these workers the effect could have been due to the auxins produced by the axillary buds on the stem cuttings. The present results do not agree with this idea, since when the axillary bud was completely removed, thus eliminating the possible auxin source, gibberellic acid still promoted rooting. The present results point to a direct effect on root initiation by gibberellic acid.

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