

STIMULATION OF STEM GROWTH IN  
VEGETATIVE TILLERS OF *POA PRATENSIS* L.  
BY ETHEPHON: ELONGATION OF NODES

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Application of ethephon ((2-chloroethyl)phosphonic acid, ethrel, CEPA) has been shown to stimulate elongation of internodes in vegetative tillers of *Poa pratensis* L. and *Avena sativa* L. (VAN ANDEL 1970; VAN ANDEL & VERKERKE in press). Occasionally the plants produced one or two internodes of abnormal shape. This phenomenon is described in the present paper. For details of the experiments we refer to our other publications.

Some basal internodes of vegetative tillers of *P. pratense* L. cv. Prato, treated with ethephon appeared to consist of two parts: a short, comparatively thick lower part, with a tiller sprouting just at the top of it (*plate IC* and *ID*, 3*a*) and a longer thinner upper part (*plate IC* and *ID*, 3*b*). The tiller occurred on the same side of the stem as the subtending leaf and in the axil of this leaf the bud was lacking. So it seems likely that it was the axillary bud, which after moving upwards had given rise to the tiller, and not an adventitious bud. In this case the "lower" part of the stem, between the tiller and the insertion of the lower leaf (*plate IC* and *ID*, 3*b*) should be considered as a part of the node, which normally does not elongate. Only the "upper" part, the part above the tiller, would be the internode. Support for this idea was sought by studying the course of the vascular bundles in a series of transverse and longitudinal stem sections. In the "upper" part the vascular bundles were arranged practically in a single ring, as is typical for *Poa* (STIFF & POWELL 1974); but the "lower" part showed two adjoining rings with a few vascular bundles in common. Close to the region where the tiller had developed from the stem the latter bundles started to ramify (*plate II*). The course of the anastomoses showed a close resemblance to that in the nodes of untreated plants.

STIFF & POWELL (1974) defined an internode as the part of the stem in which all vascular bundles are longitudinal and parallel to the long axis. According to this definition the "upper" and "lower" part would be parts of the internode. The idea of SHARMAN (1942), elaborated by MADISON (1970), however, supports our view. According to these authors the disc of insertion of leaf primordia of Gramineae consists of two portions, between which the internode may develop by cell divisions in the lower portion. The basal part of a mature node would thus be the top of the disc of insertion associated with the leaf inserted on the node concerned, whereas the upper part of the node is the base of the disc of insertion of the leaf above. The tissue of the upper part of the node would then be younger than that of the basal part, and, being still capable of growth and

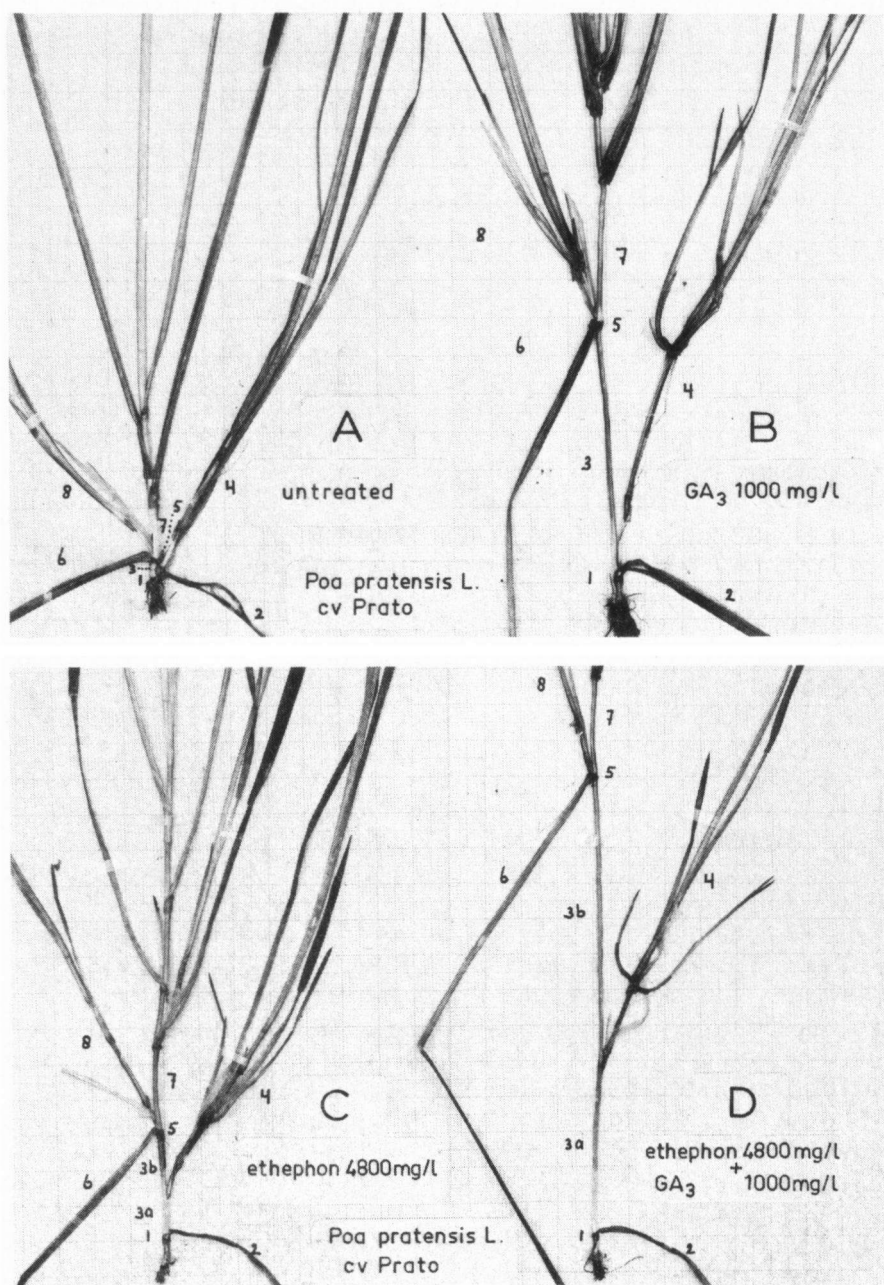


Plate I. Effect of ethephon and GA<sub>3</sub> on stem growth of vegetative tillers of *P. pratensis* L. cv Prato. A: untreated; B: GA<sub>3</sub>; C: ethephon; D: ethephon + GA<sub>3</sub>. Leaf 1 is the leaf emerged but not yet fully expanded at the time of treatment, leaf 2 the next younger leaf. The picture was taken 8 weeks after treatment. The leaves have been loosened to uncover the stems.

1: place of insertion of leaf 1; 2: sheath of leaf 1; 3a: elongated node, presumably (see text); 3(b): internode; 4: axillary tiller to leaf 1; 5: place of insertion of leaf 2; 6: sheath of leaf 2; 7: internode; 8: axillary tiller to leaf 2.

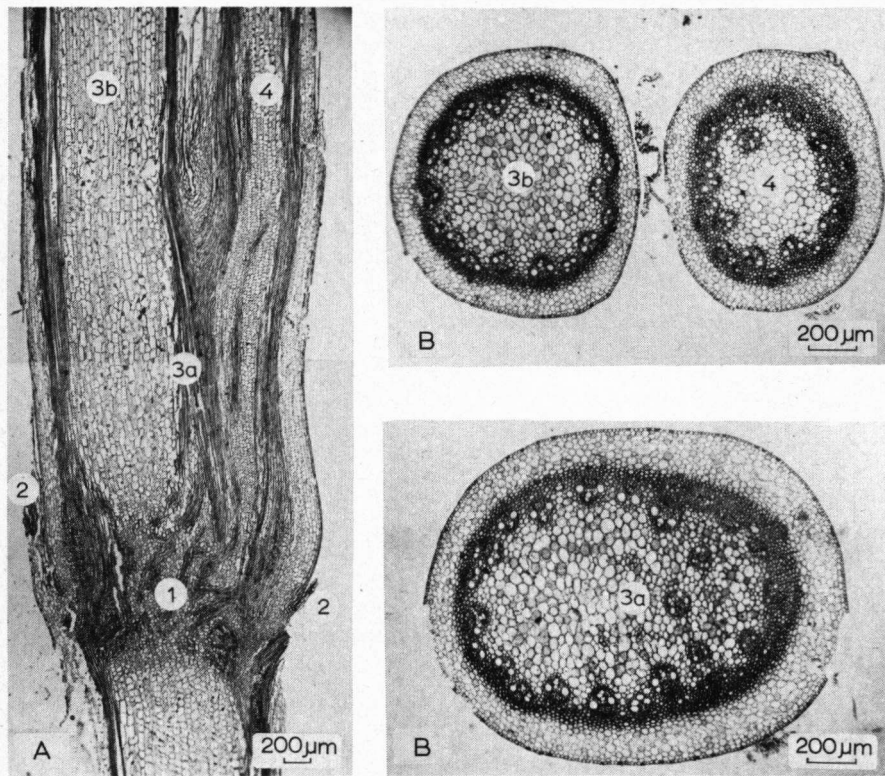


Plate II. Longitudinal section (A) and transverse sections (B) of abnormally developed stems of ethephon treated plants of *P. pratensis* L. cv Prato, stained with haematoxyline (Delafield) and safranin. For explanation of the figures see legend Plate I.

differentiation, initiate new roots and an axillary bud. It would only be this younger part that could be made to elongate by the treatment with ethephon.

Node elongation was observed only occasionally, mainly when comparatively old tillers were used (cf. VAN ANDEL & VERKERKE, in press), and only in certain nodes, as mentioned already. This means that other factors must be involved besides the presence of ethephon. Nodes did not respond to exogenous gibberellic acid ( $GA_3$ ), which stimulated the growth of the internodes considerably (plate 1A and 1B, 3, 7). However, simultaneous application of ethephon and  $GA_3$  resulted in the development of much longer nodes than ever observed after treatment with ethephon alone (table 1; plate 1).

Using data on the length of internode epidermal cells we have concluded that increased internode growth after treatment with ethephon was mainly a matter of increased cell elongation (VAN ANDEL & VERKERKE, in press). Such data cannot be obtained for the nodes of untreated plants, so we cannot say anything about the effect of ethephon itself. Comparison of plants treated

Table 1. Abnormal stem development of vegetative tillers of *Poa pratensis* L. cv Prato, after treatment with ethephon, GA<sub>3</sub>, and ethephon + GA<sub>3</sub>. Figures represent the average of measurements on 16 plants, 8 weeks after treatment. Cell length was determined on 40 cells per plant; cell number was estimated by dividing the length of the stem part by the length of its epidermal cells. Leaf 1 is the leaf emerged but not yet fully expanded at the time of treatment, leaf 2 the next younger leaf.

Treatment	Distance between insertion of leaf 1 and 2 (mm)		Epidermal cell length (μm)		Epidermal cell number	
	lower part <sup>1</sup>	upper part <sup>2</sup>	lower part	upper part	lower part	upper part
Untreated	—	4	—	53	—	82
Ethephon, 4800 mg/l	4	17	164	150	26	114
GA <sub>3</sub> , 1000 mg/l	—	55	—	184	—	293
Ethephon, 4800 mg/l + GA <sub>3</sub> , 1000 mg/l	11	66	210	297	53	223

<sup>1</sup> Stem part between insertion of leaf 1 and that of axillary tiller.

<sup>2</sup> Stem part between insertion of axillary tiller and that of leaf 2.

— Too short for measurement.

with ethephon, and with ethephon and GA<sub>3</sub> simultaneously, suggests that nodes as well as internodes respond to application of GA<sub>3</sub> with an increase in cell length and in cell number. The differences of the values for the nodes, however, are not significant at the  $P = 0.05$  level owing to the variability of the plants treated with both ethephon and GA<sub>3</sub>.

At first sight the phenomenon described above resembles the geotropic reaction of lodging stems of cereals. In the case of *Zea mays* elongation of the node is involved in lodging but we have found no effect of ethephon on nodes of maize plants (unpublished results). In other plants such as *Triticum vulgare* it is the leaf sheath base which elongates at lodging (ARLSAN & BENNET CLARK 1960; MAEDA 1958). Either way, it is according to the authors just mentioned a specialized parenchymatous ground tissue in the differentiated stem or leaf sheath which responds to the geotropic stimulus by stretching.

In the stems of *Poa*, however, young meristematic tissue is involved.

#### ACKNOWLEDGEMENT

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#### REFERENCES

- ANDEL, O. M. VAN (1970): Dual effect of 2-chloroethanephosphonic acid on vegetative grasses. *Naturwissenschaften* **57**: 396–397.  
 — & D. R. VERKERKE (in press): Stimulation and inhibition by ethephon of stem and leaf growth of some Gramineae at different stages of development. *J. Exp. Bot.*  
 ARSLAN, N. & T. A. BENNET CLARK (1960): Geotropic behaviour of grass nodes. *J. exp. Bot.* **11**: 1–12.

- MADISON, J. H. (1970): An appreciation of monocotyledons. *Notes Roy. Bot. Garden Edinburgh* **30**: 377–390.
- MAEDA, E. (1958): The effects of growth regulators on the geotropism of leaf sheath basal region in wheat plant. *J. exp. Bot.* **9**: 343–349.
- SHARMAN, B. C. (1942): Developmental anatomy of the shoot of *Zea mays* L. *Ann. Bot. N.S.* **6**: 245–282.
- STIFF, M. L. & J. B. POWELL (1974): Stem anatomy of turf grass. *Crop. Sci.* **14**: 181–186.