PLANT HORMONES IN ACTION

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The auxin concept

A phytohormone has accepted, for about 60 years, as being biocompound which is produced in any part of a plant. It is transported from the site of its biosynthesis to a site of its action. A growth phytohormone is involved in the regulation of growth. Such organic and natural substance is essential to the irreversible enlargement (length and width) of the plant cells. The term auxin was first suggested to refer to a natural compound active in the Avena test of curvature, first proposed by Fritz Went (1928). The first auxin which was extracted, purified and for which the chemical structure was analyzed (Kögl, 1934) is the indole-3yl-acetic acid (IAA). The term Plant Growth Regulator is used for an organic substance, other than auxin and nutrient, which can modify - in small amounts - the cell growth. Finally, the term Plant Growth Substance is proposed for synthetic auxin. Unfortunately quite a lot of scientists do not strictly respect this useful nomenclature.

Today, the concept of auxin is strongly diversified. It is clear that other compounds than IAA are considered also as auxins. All these endogenous substances are characterized by their metabolism, controlled by several specific enzymes. The anabolism corresponds to the reactions in vivo which induce the biosynthesis of auxins. The catabolism groups all the processes in vivo of biodegradation of auxins. The active movement of auxins inside the plant tissues is "polar," from the part in which auxins were formed to that of their action. Such kind of transport is dependent on some specific carriers as well as the biological nature of the cells. Several factors may change the velocity and the intensity of the auxin movement as the temperature, light, pH ...

Finally, at the end of the trip, auxin has to be fixed to a specific receptor which is attached to a membrane (for instance the plasmalemma of the cell). The activity of each auxin molecule is expressed by a second messenger which induces the divers auxin rapid and slow actions.

Some informations about auxins in growing roots

For quite a long time, we have been interested - in my Institute - in the study of the auxin level in maize roots. And this in relation to several topics as growth regulation, gravireaction, senescence, water stress, transformed anduntransformed plants, interaction between IAA and abscisic acids (ABA) ... I just want to discuss a few problems actually in progress in my laboratory.

Auxin content in relation to growth gradients

The level of IAA in different parts of primary maize roots was measured using gas chromatography (GC) and mass spectrometry (MS). Both free and ester IAA have been tested. First the content in IAA was tested in whole roots. Our data clearly show the level of free IAA is stable throughout the period of culture examined. However, the level of ester IAA decreases sharply from the first day, when it was 5 times higher than that of free IAA and by day five is equal to that of free IAA. This could indicate that ester IAA, from the caryopsis, is the major source of IAA in the roots at the beginning of germination. To test Whether there is a relationship between levels of free and ester IAA and growth, the content of these two compounds was measured in the elongation zone from roots of different ages. It has been found that ester IAA decreases about the same rate as in the whole roots. On the contrary, the level of free IAA changes little till the days six and increases dramatically after the time. Thus a higher level of IAA in the growing part of roots corresponds to a lower growth rate. Similar data were obtained when IAA was tested in roots selected from different growth classes from a population of 2-day-old maize roots. For instance, the elongation

rate ($mm.h^{-1}$) being 0.4, 0.8 and 1.2, the IAA content (in ng per g of FW) was respectively for ester IAA, 74, 59 and 54 and for free IAA, 40, 28 and 17.

Endogenous IAA neosynthesis

The source of IAA in young root has never been conclusively identified. Studies based on the transport of the radiolabelled hormone indicate that most of auxins could arisen from the caryopsis, having a preferential acropetal movement in roots. The *in vivo* bioformation of deuterium-labelled IAA in maize roots was found to occur by measuring the incorporation of ^{2}H from $^{2}H_2O$ into the IAA molecules for intact roots from plantlets and from root segments cultured *in vitro*. From quite a lot of significant data it was concluded that a *de novo* IAA catabolism takes place very early inside the roots. Such pathway might make an appreciable contribution to the auxin responsible for the growth regulation.

Local applied IAA

Quantitative experiments with applied IAA can only be done when the level of the exogenous IAA which enters the tissues is possibly measured. The technique which we used is based on the application of some resin beads containing a given concentration of radiolabelled IAA. By testing it regularly in the beads during the incubation time, it is possible to know exactly the uptake of IAA by the root tissues and which was accumulated on the root surface. The differential elongation responses were induced after asymmetrical application of IAA-loaded beads along the root elongation zone and were modulated according to the initial growth rates of these roots. The amplitude and location (midpoint) of curvature, the elongation of the roots and the IAA uptake were measured. The amount of bending depended on the location of the bead and upon the amount of the IAA taken up. Several interesting data have been obtained related to the growth regulation of roots, the changes of their IAA level, the IAA transport and the redistribution of IAA on both sides of curving roots. Such kind of observations give some new informations about the

relations between the initial growth of roots and their endogenous auxin content, this in connection with the responses of the elongating cells to a redistribution of IAA due to the applied IAA or to the action of gravity.

References

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