Pathways of Auxin Transport in the Intact Pea Seedling (*Pisum sativum* L.)

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Summary. When small colonies of the pea aphid (*Acyrthosiphon pisum* (Harris)) were established on the stem of Meteor Dwarf Pea seedlings (*Pisum sativum* L.), \(^{14}C\) was found in the honeydew 4.5 h after applying IAA-\(^{14}C\) to a fully-expanded foliage leaf. In contrast, no activity was found in the honeydew or aphids 4.5 h after the application of IAA-\(^{14}C\) to the intact apical bud even though the internode upon which the aphids were feeding contained high levels of \(^{14}C\). The lack of radioactivity in aphids feeding on stems to which IAA-\(^{14}C\) was applied via the apical bud was found not to be influenced by the internode position or by the transport interval allowed (up to 24 h).

Radioactivity derived from either foliar or apical applications of IAA-\(^{14}C\) was not transported through stem tissues killed by heat treatment. Xylem function was shown not to be impaired by the heat treatment employed.

It was concluded that the long-distance transport of IAA from the apical bud of intact pea seedlings does not take place in the phloem sieve tubes involved in the transport of metabolites from foliage leaves, or in the non-living tissues of the xylem.

Introduction

The results of previous investigations of the transport of \(^{14}C\)-labelled indoleacetic acid (IAA) in the intact pea seedling (*P. sativum*) have demonstrated that IAA applied to the apical bud may be transported through the entire length of the stem and roots, probably as the unchanged acid (Morris, Briant and Thomson, 1969). Recently, Hollis and Tepper (1971) have demonstrated a similar long-distance transport of IAA-\(^{14}C\) following its application to the apical bud of intact white ash seedlings (*Fraxinus americana* L.).

Estimated velocities of this transport through intact plants, in the range 0.3 to 1.5 cm per h (Morris *et al.*, 1969; Hollis and Tepper, 1971), are of the same order of magnitude as the velocities of auxin transport in excised coleoptiles and stem segments in several species (Goldsmith, 1969); they are considerably slower than velocities estimated when labelled IAA is applied to mature foliage leaves or to maize scutella, which may be as high as 24.0 cm per h (Little and Blackman, 1963; Eschrich, 1968; Brossard and Tepper, 1969).
There is now considerable evidence that when applied to foliage leaves, IAA and related compounds such as 2,4-dichlorophenoxyacetic acid (2,4-D) are transported with assimilates in the phloem. Export of exogenous auxin from the leaf occurs only when the leaf is exporting assimilate (Rohrbaugh and Rice, 1949; Kadir and Morris, in prep.); patterns of distribution of the applied auxin are similar to those expected for assimilate moving from the leaf, and may be influenced by the position of sinks (Fang and Butts, 1957; Fletcher and Zalik, 1965; Bollag and Gallun, 1966; Whitehouse and Zalik, 1967; Hoad, Hillman and Wareing, 1971); and the applied auxin can be recovered in the honeydew or stylet exudate of aphids feeding on the stem (Eschrich, 1968; Hoad et al., 1971). All these observations are consistent with the view that the transport of exogenous auxin applied to leaves takes place in the phloem sieve tubes.

The long-distance transport of 14C-labelled IAA applied to the intact apical bud differs in a number of ways from the apparent phloem transport of IAA applied to leaves. Not only do velocities differ considerably, as already indicated, but in marked contrast to the export of exogenous auxin from foliage leaves, the export and transport of IAA-14C from the apical bud of pea seedlings is not dependent on the transport of assimilates in the phloem, and will occur in both light-grown plants and plants maintained in darkness (Morris, 1970). Furthermore, whereas IAA-1,14C is readily exported from the apical bud of intact pea seedlings, the radioactivity from uniformly labelled sucrose-14C applied to the apical bud is not transported beyond the growing tissues situated immediately below the bud, which presumably act as a sink for the translocated compounds (Kadir and Morris, in prep.). While the transport of IAA-1,14C applied to the apical bud is completely inhibited by the application of 2,3,5-triiodobenzoic acid (TIBA) to the stem, the export of both IAA-1,14C and sucrose-14C from foliage leaves is not influenced by TIBA treatment (Barry, 1971; Kadir, Morris and Barry, in prep.). Together, these observations suggest that the long-distance transport of auxin from the apical bud of intact plants may involve different transport mechanisms and may take place in cells which differ from those involved in the transport of assimilates and of exogenous auxin from foliage leaves.

The possible existence of two, physically distinct, pathways of auxin transport in intact plants has been suggested previously by Smith and Jacobs (1969), who visualize a relatively rapid transport of auxin in the phloem, and a slower, polar, transport of auxin in a non-phloem pathway. The basipetal transport of auxin from the apical bud, which in the pea is probably the principal source of auxin (Scott and Briggs, 1960), is directly opposed to the predominant direction of transport of assimilates in the phloem which, in the upper regions of the stem, is likely to be