Anatomical observations on the influence of morphactin on wood formation of *Carpinus betulus* L. and *Syringa vulgaris* L. shoots

M. SMOLIŃSKI *, M. SANIEWSKI **, J. PIENIAŻEK **, J. E. PHELPS *
and E. A. McGINNES, Jr. *****

* Department of Cytology and Cytochemistry of Plants, Institute of Physiology and Cytology, University of Łódź, ul. Banacha 12/16, 96-237, Łódź, Poland

** Research Institute of Pomology and Floriculture, Skierniewice, Poland

*** School of Forestry, Fisheries and Wildlife, University of Missouri, Columbia, Mo. 65211, USA

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Abstract

The effect of morphactin IT 3456 on wood differentiation in *Carpinus betulus* and *Syringa vulgaris* was studied. In both species morphactin strongly stimulated production of wood but xylary differentiation was abnormal. Cellular differentiation was altered in that vessels were considerably smaller on transverse section and shorter than normal. Fibers and tracheids were also much shorter. It appeared that all cell types were disorientated from their longitudinal axis. It is probable that the effect of morphactin is caused by an inhibition of basipetal auxin transport and by the disturbance of general cell polarity during cambial divisions.

INTRODUCTION

It is well known that cell differentiation and mitotic activity of the cambial zone are controlled by growth substances among which auxin plays a key role (Digby and Wareing, 1966; Balatinecz and Farrar, 1966; Pieniążek and Saniewski, 1968; Roberts 1969). In previous studies we have shown that morphactins strongly induced the formation of compression wood in vertically growing shoots of *Picea excelsa* and *Pinus silvestris* (Smoliński et al., 1972; Phelps et al., 1974) and on the upper side of lateral branches of *Larix decidua* (Saniewski et al., 1977) and *Thuja occidentalis* (Phelps et al., 1977). Compression wood is normally produced on the lower side of inclined stems and branches of these and other gymnosperm species as a response to normal geotropic conditions. Its

formation is connected with a different redistribution of auxin on the lower and upper side of branches (Westing, 1965; 1968).

We have also found that morphactins strongly inhibited tension wood formation on the upper side of bent shoots of *Aesculus hippocastanum*. The pattern of wood differentiation was changed, altering it to favor vessel-type cell formation (Smoliński et al., 1974). In natural conditions tension wood is produced on the upper side of inclined stem and branches of angiosperms as a response to natural geotropic conditions.

The stimulatory effect of morphactins on compression wood formation and the inhibitory effect on tension wood formation is probably caused by some inhibitory action of morphactins on longitudinal and transverse transport of endogenous auxin, and by a synergistic action of morphactins with endogenous auxin and cytokinins on cambial activity (Saniewski et al., 1977).

In this work we report further anatomical observations on the influence of morphactin on wood differentiation in shoots of *Carpinus betulus* and *Syringa vulgaris*.

MATERIAL AND METHODS

One-year-old vertically growing shoots of *Carpinus betulus* L. and *Syringa vulgaris* L. were treated with morphactin IT 3456 on June 1, 1975. The morphactin was applied at a concentration of 0.5% in lanolin paste as a ring around the shoots. Control shoots were treated with lanolin only. Six shoots were used per treatment. The treated shoots were collected on October 27, 1975 and fixed in 75% ethyl alcohol for light and scanning electron microscopic analysis. Microscopic analyses were made below the place of treatment, at the place of treatment and above the place of treatment. The method of light microscopic analysis was the same as previously described (Smoliński et al., 1972). The preparation of wood samples for scanning electron microscopic analysis was also as previously described (Phelps et al., 1974).

RESULTS

The shoots of *Carpinus betulus* and *Syringa vulgaris* treated with morphactin were strongly thickened at the place of application (Figs. 1A, 2A). It was caused both by a marked increase in wood production and by an increase in phellogen activity which resulted in a wide layer of phellodorm and phellem. Normal wood formation was observed around shoots prior to morphactin treatment (Figs. 1B, 2B). Follow-

Fig. 1. For explanation see on the next page

Fig. 1. The effect of morphactin IT 3456 on anatomical changes in the wood of *Carpinus betulus* shoots

- A — morphactin treated shoot; strong thickening of shoot is visible: a — place of application, b — 4 cm below treatment,
- B — transverse section of natural wood 1.5 cm below treatment with morphactin; a — wood formed in 1974, b — wood formed in 1975, $\times 130$,
- C — transverse section of morphactin induced wood; a — natural wood formed in 1975 before morphactin treatment, b — morphactin induced wood, $\times 130$,
- D — transverse section of morphactin induced wood, $\times 400$,
- E — longitudinal radial section of natural formed wood, $\times 130$,
- F — longitudinal section of morphactin induced wood, $\times 130$,
- G — longitudinal section of natural wood, scanning electron micrograph, $\times 500$,
- H — longitudinal section of morphactin induced wood, scanning electron micrograph, $\times 500$.

Fig. 2. For explanation see on the 4 page

Fig. 2. The effect of morphactin IT 3456 on anatomical changes in the wood of
Syringa vulgaris shoots

- A — morphactin treated shoot; strong thickening of shoot is visible,
- B — transverse section of natural wood 1.5 cm below treatment with morphactin: a — wood formed in 1974, b — wood formed in 1975, $\times 130$,
- C — transverse section of morphactin induced wood: a — natural late wood formed in 1974, b — natural wood formed in 1975 before morphactin treatment, c — morphactin induced wood, $\times 130$,
- D — transverse section of natural formed wood, $\times 400$,
- E — transverse section of morphactin induced wood, $\times 400$,
- F — longitudinal radial section of natural formed wood, $\times 130$,
- G — longitudinal radial section of morphactin induced wood, $\times 130$,
- H — longitudinal section of natural formed wood, scanning electron micrograph, $\times 300$,
- I — longitudinal section of morphactin induced wood, scanning electron micrograph, $\times 300$.

ing application of morphactin, cellular differentiation was altered in that vessels were considerably smaller than normal on transverse section. The vessels approached the size of the surrounding fibers and tracheids (Figs. 1C, D, 2C, D, E). The vessels, tracheids and fibers were also much shorter (Table 1). It appeared that all cell types were disorientated from their longitudinal axis after morphactin was applied and they also appeared to have a thicker cell wall than normal (Figs. 1E, F, G, H, 2F, G, H, I). Since the cells were not enlarged it appeared that a proliferation in cell numbers is responsible for the pronounced swelling of the treated region.

Table 1

A comparison of the sizes of some elements of natural and morphactin induced wood in *Carpinus betulus* and *Syringa vulgaris* shoots (in μm); the average of 50 measurements are given in brackets

Investigated elements	Natural wood	Morphactin induced wood
<i>Carpinus betulus</i>		
Length of vessels	250-525 (403)	125-230 (195)
Width of vessels	25-70 (52)	20-35 (23)
Length of fibers	620-910 (755)	500-650 (511)
Width of fibers	12-28 (21)	19-21 (20)
Length of tracheids	300-450 (420)	200-370 (288)
Width of tracheids	15-30 (19)	15-25 (18)
<i>Syringa vulgaris</i>		
Length of fibers+tracheids *	321-535 (426)	110-290 (212)

* It was difficult to separate fibers from fiber tracheids in *Syringa* wood, thus, these elements were measured together.

DISCUSSION

It is well known that morphactins inhibit both longitudinal and lateral transport of auxin in plants (Bopp, 1972). Thus, it seems that the stimulatory effect of morphactin on increase of wood formation in *Carpinus* and *Syringa* shoots was due to an inhibitory effect of this compound on basipetal auxin transport which resulted in accumulation of auxin in the treated area. Synergistic action of morphactin with endogenous auxin and cytokinin on cambial activity is also possible (Saniewski et al., 1977). Abnormal differentiation of wood elements induced by morphactin may be explained also by accumulation of high level of auxin in the treated area, since it is well known that application of exogenous auxin with cytokinins or gibberellin to apple shoots

caused similar effect (Pieniążek and Jankiewicz, 1966; Pieniążek and Saniewski, 1968). Disturbance of cell polarity during cambial divisions due to treatment with morphactin could also be contributing factor in this phenomenon (Bopp, 1972; Lavania, 1977).

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**Obserwacje anatomiczne wpływu morfaktyny
na tworzenie się drewna w pędach**
Carpinus betulus L. i *Syringa vulgaris* L.

Streszczenie

Badano wpływ morfaktyny IT 3456 podanej w paście lanolinowej w stężeniu 0,5% wokół pionowych pędów grabu i lilaka na tworzenie się drewna. W obu gatunkach morfaktyna powodowała silnie zwiększony przyrost drewna ale było ono nienaturalnie zróżnicowane. Naczynia były wąskie i na przekroju poprzecznym nie różniły się od włókien i cewek. Naczynia, cewki i włókna były znacznie krótsze i wykazywały zakłócony rozwój wzdłuż osi pionowej. Sugeruje się, że taki wpływ morfaktyny na tworzenie się drewna może być powodowany hamowaniem do podstawowego transportu auksyn i zakłóceniem ogólnej polarności w czasie podziału komórek kambium.