# INTERACTION OF ROOT-APPLIED 2,4-D AND COLCHICINE ON MORPHOGENESIS

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Microtubules (MT) have been shown to play an important role in cell division and cell shape (1). It has long been known that endogenously applied colchicine affects plant morphogenesis in a manner similar to that of some phytohormones (2), but the extent to which phytohormones and colchicine interact to influence MT-disorganization is not yet clear (1, 2, 3). This prompted me to perform some experiments using the 2,4-D culture system for etiolated pea seedlings (4).

It is well known that colchicine in low concentrations acts on the microtubule system, in particular on the MT of the mitotic spindle ($10^{-6}$ M). In higher concentrations colchicine is known to induce peculiar swellings in root tips named "C-tumors" (2), giving rise to the idea that because of these morphogenetic effects it acts like a phytohormone. Less known are the macroscopic effects on shoot development as we found in our culture system.

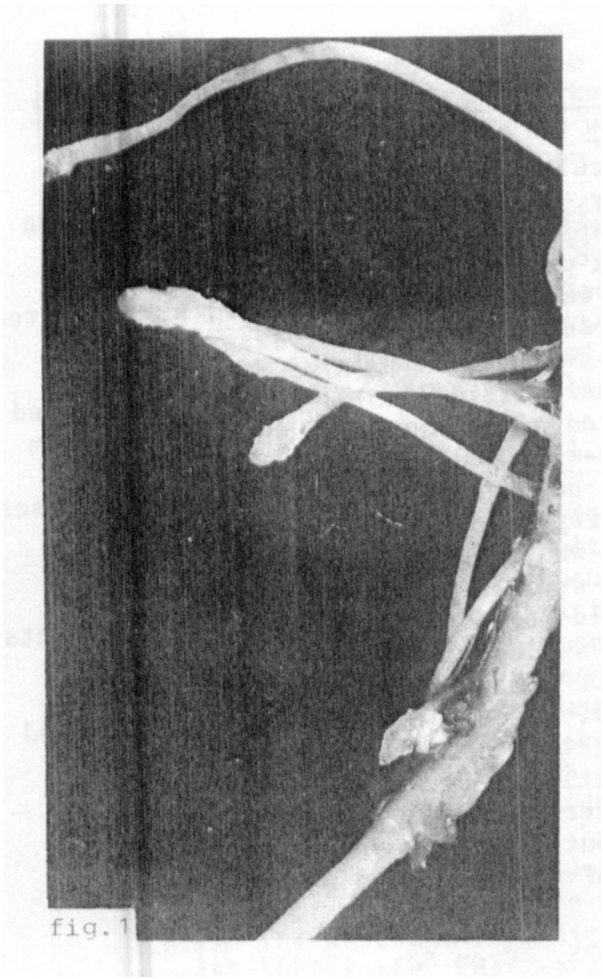


Fig. 1. "C-tumors" induced by colchicine.

One-week-old etiolated pea seedlings were used for studying auxin-colchicine interactions. The seedlings were treated with colchicine ($5 \times 10^{-3}$ M and colchicine/2,4-D ($5 \times 10^{-3}$ M/$10^{-4}$ M; 24 h root-applied) and further cultivated on moist vermiculite for one week (light/dark: 16/8 h; 2500 lux). Under these conditions colchicine induced C-tumors in root tissue of the seedlings (Fig. 1). In the shoots, basal and apical parts were strongly swollen and their length reduced; the development of the green leaves was inhibited (Fig. 2). This effect shows some similarities to the morphology of fasciated mutants and may be a hint for the understanding the basic mechanism leading to fasciation. If colchicine under these conditions acts mainly as MT-disorganizer, abnormal formation of spindle or cortical microtubules during cell division or growth may play an important role during the induction of the observed growth aberrations in our plants.

On the other hand it is known that auxins induce similar depolarized growth in plants. The questions raised are: What are the differences between auxin-induced and colchicine-induced morphogenetic aberrations leading to the death of the plants and what kinds of interaction exist?

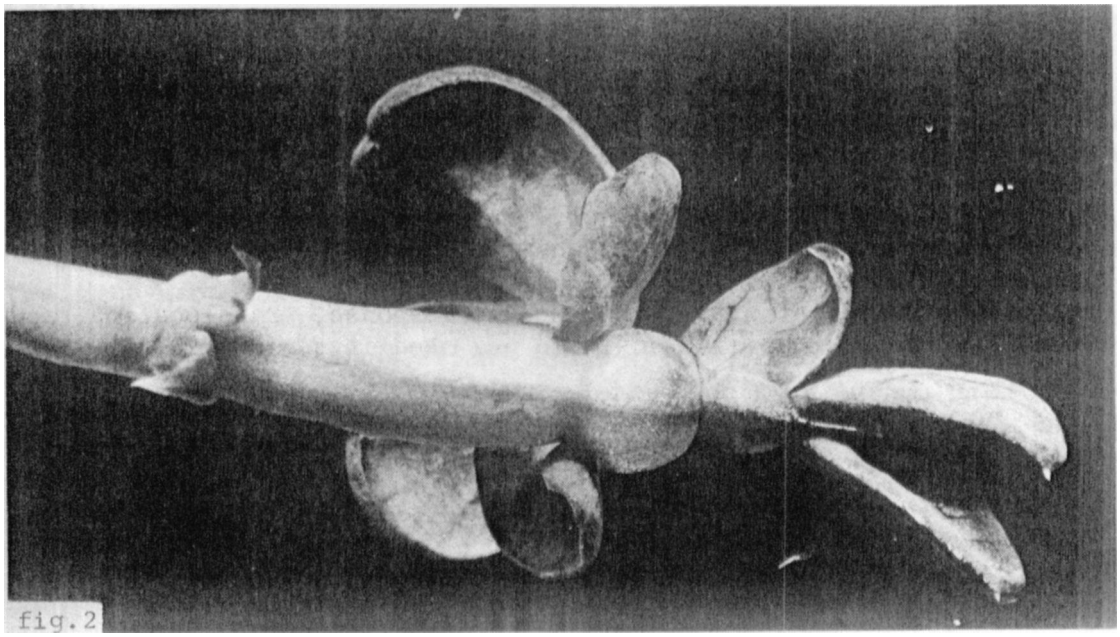


Fig. 2. Effect of colchicine on shoot morphogenesis. Note swollen stem and inhibited leaf development.

Our investigations revealed that the application of both 2,4-D and colchicine to the roots leads to strongly inhibited root and shoot development. We observed tissue swelling of the primary and lateral roots leading to ruptures, which often are observed for 2,4-D alone in this concentration range (4). Some swelling occurred in the root tip region, but to a lesser degree than in seedlings treated with colchicine alone (Fig. 3). Shoot morphogenesis was similar to that of seedlings treated with colchicine alone, but the inhibition appeared to be stronger. Typical 2,4-D effects such as induction of lateral or adventitious roots and formation of callus-like structures were not observed under these conditions. This demonstrates that the drastic morphogenic effects of 2,4-D (4) were repressed by the joint treatment with colchicine. A repression of auxin-induced growth by colchicine and other MT-disorganizers has already been demonstrated with wheat coleoptile segments (3). It is assumed that polymerization of MT-subunits is required for normal growth to occur. The effect of both compounds on polarity of single cells is known. In the case of colchicine it was clearly demonstrated that cells of untreated controls stretch mainly in longitudinal axial directions, while cells of colchicine treated roots expand transversely with a maximum in the cortical tissue above the root tip (2). This observation, led Levan to conclude that a similar increase in cell size results in C-tumors just as in auxin-induced enlargement. With respect to the biochemical action of colchicine on the MT-organization, the present investigations confirm the hypothesis that expression of normal and abnormal morphogenesis in plants depends on the basic mechanism of MT-formation within the cell, which probably is mediated somehow by intercellular regulators like auxins.

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3. Lawson, R. V. and R. L. Weintraub. Interactions of microtuble disorganizers, plant hormones and red light in wheat coleoptile segment growth. Plant Physiol. 55:1062-1066. 1975.
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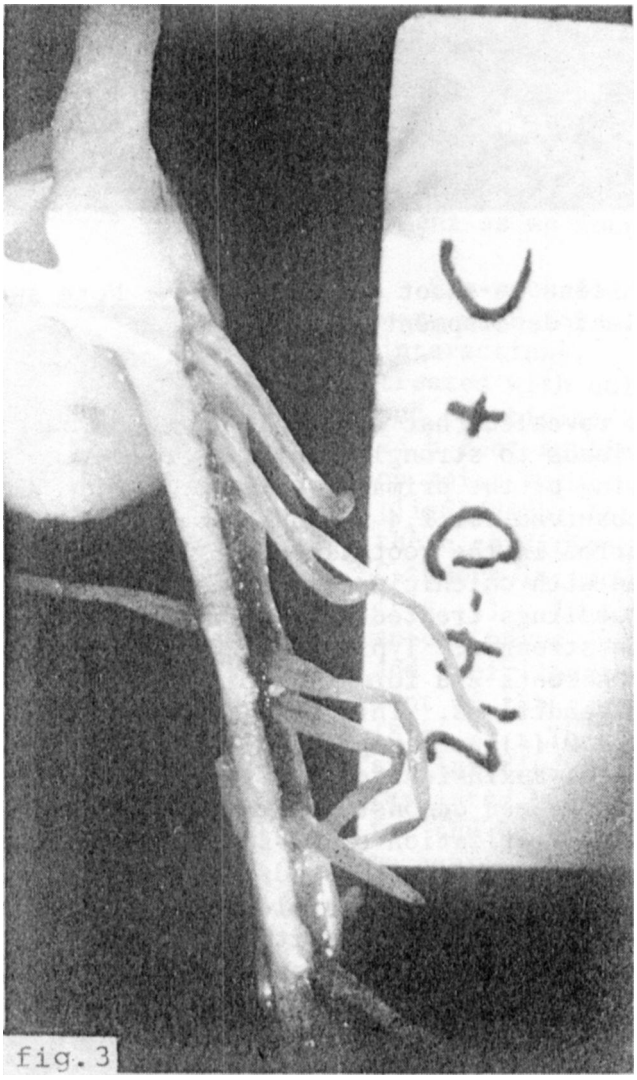


Fig. 3. Combined effect of colchicine and 2,4-D on root development.