Woody stem itself senses light environment and phototropically bends by asymmetrical xylem formation

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Introduction

Plants control posture of stems, so that they optimize photosynthesis of leaves and dispersal of pollen and seeds under mechanical restrictions. For elongating stems, phototropism, gravitropism, and autostraightening have been known. However, it is only gravitropism and autostraightening that have been recognized and existence of phototropism had not been documented for non-elongating and radially growing stems (hereafter, woody stems) characteristic of woody plants. Woody stems of angiosperm species gravitropically bend by asymmetrical formation of tension wood and normal wood and thus asymmetrical generation of longitudinal tensile stresses during maturation of the xylem toward one side of the stems. Recently, we have found out that woody stems do reveal phototropism and that it is implemented by the asymmetrical xylem formation (Matsuzaki *et al.* 2007), as such occurs for gravitropism of woody stems. Preliminary experiments suggested that woody stem itself rather than leaves is a photoreceptive site in the phototropic bending of woody stems. In this study, we examined role of woody stem as a photoreceptive site and longitudinal signal transmission of information on light gradient.

Experimental settings and results

We inclined one-year-old potted seedlings of a deciduous oak *Quercus crispula* Blume 45º from the vertical and grew them under overhead fluorescent illumination. We defined the stem portion that had elongated within a given growth flush as a growth unit (GU). Among three GUs consisting inclined one-year-old main stems, the middle GU was laterally illuminated with an array of blue light emitting diodes (LEDs). Significant bending and asymmetrical tension wood formation toward the flank illuminated with blue LEDs at the middle GUs was observed compared with the middle GUs of non-treated seedlings. GUs basal and apical to the middle ones, which were not illuminated laterally with the blue LEDs, showed neither lateral bending nor lateral asymmetry in xylem formation.

Conclusions

It is shown that gradient in light environment is perceived by woody stem itself and that the gradient locally induces asymmetrical xylem formation and resulting bending. Acropetal and basipetal transmission of information on the light gradient is not apparent. Integrating phototropism of woody stems into functional-structural plant models may improve prediction of tree architecture and photosynthesis under spatially heterogeneous light environment.

References

Matsuzaki, J., Masumori, M., and Tange, T. (2007) Phototropic bending of non-elongating and radially growing woody stems results from asymmetrical xylem formation. *Plant, Cell and Environment* **30,** 646-653.