Researchers identify light quality effects on genes regulating branching

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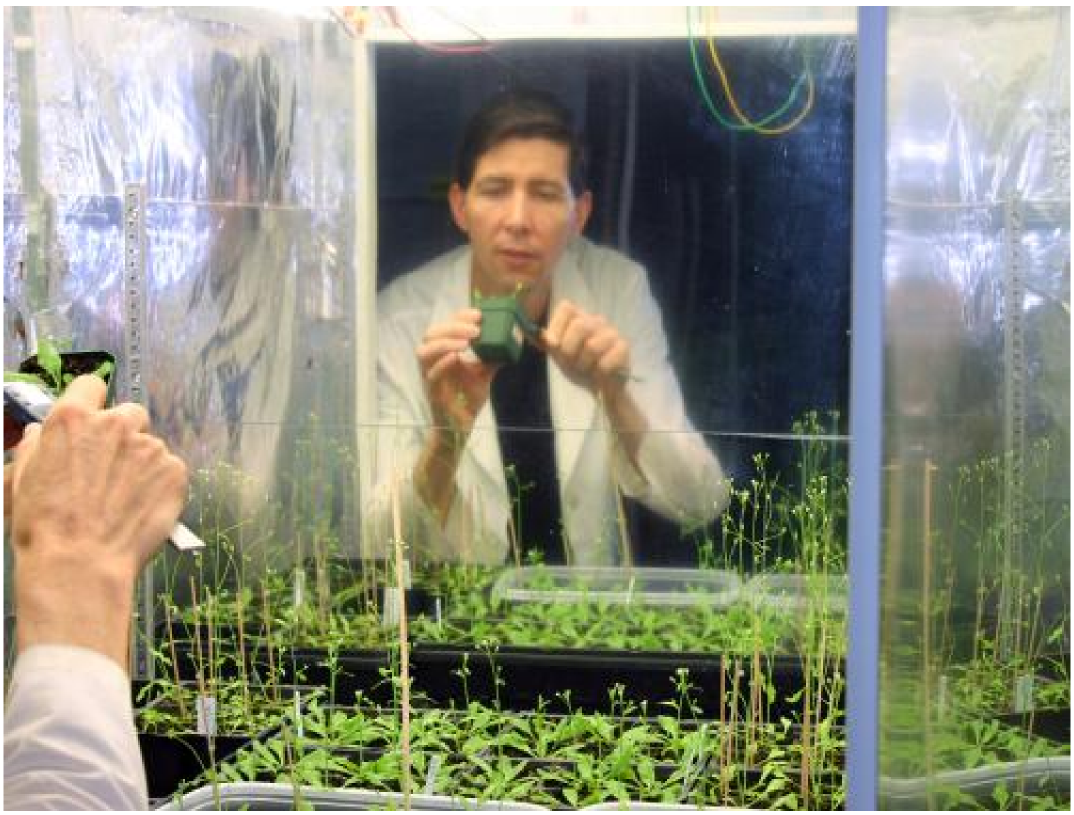

Dr. Scott Finlayson, Texas A&M AgriLife Research scientist, examines plants in the red and far-red light study. Credit: Texas A&M AgriLife Research photo

(Phys.org) —The naked eye might not be able to discern the difference between red and far-red wavelengths of sunlight, but plants can, and they use the light to alter their overall architecture, according to Texas A&M AgriLife Research scientists.

The study capturing these findings will be featured in the journal *Plant Physiology* in October, and the researchers also outline how this knowledge could help in designing crops in the future to adapt to variable growing environments, such as drought, high temperatures and grazing.

The study identifies the role of the plant growth regulator, abscisic acid, in suppressing axillary bud outgrowth in response to reduced red to far-red light ratio, which plants usually sense under dense canopies, said Dr. Scott Finlayson, the principal investigator and Texas A&M University soil and crop sciences associate professor in College Station.

Finlayson said not much is known about the branching or tillering process at the gene level and the study has practical applications to modify plant architecture, specifically tillering and biomass production in wheat, sorghum, forage grasses and other economically important crops.

The study was part of dissertation by Dr. Srirama Krishna Reddy, AgriLife Research assistant research scientist at Amarillo, under the supervision of Finlayson, also with AgriLife Research. The study also includes contributions from Dr. Jorge Casal, from Buenos Aires, Argentina, and Srinidhi Holalu, a doctoral candidate at Texas A&M.

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Tillers, as in grasses and wheat, or branches, as in peanuts and soybeans, determine resource capture, biomass production and final yield of most crops. Environmental factors including light, temperature, water and cultural practices such as planting density, arrangement and plant nutrition determine final tillers or branches, Krishna Reddy.

"We used the model plant Arabidopsis thaliana, belonging to mustard family, to identify the genes involved in axillary bud outgrowth in response to altered red to far-red ratio, and to dissect the mechanistic basis of the process," he said.

Finlayson, who has been studying these responses for more than a decade, said plants specifically absorb red light and reflect the far-red light. Under high planting densities, more far-red light is reflected from green plant surfaces, thus reducing red to far-red ratio.

Under such conditions, plants sense competition for light and begin "shade-avoidance responses," characterized by increased plant height, reduced leaf and tiller number, early flowering, altered leaf angle and overall plant architecture.

"To study the branching process, we modified the light in the growth chambers by supplemental far-red light to mimic the shade environment and competition for light resources as seen under high plant densities, without altering plant density," Finlayson said.

He said in the study the light environment was altered by not reducing photosynthetic photon flux density, or light quantity, but by altering only the light quality in the form of reduced red to far-red ratio.

While it was already known that the red to far-red ratio could have profound effects on axillary bud growth, the extent to which it affected buds at different positions in the rosette needed to be explored, Krishna Reddy said.

The study suggests that the buds in specific positions can be selectively controlled by the red to far-red ratio, he said.

"Initially we grew the plants under shaded-type conditions, simulating high density light environment, and then we turned off the far-red light source in one part of the growth chamber, while continuing in the other part of the study on the effects of altered light quality on bud growth and gene expression," Krishna Reddy said.

"We used microarray technology to identify the genes responding to altered light quality in un-elongated axillary buds at different positions," he said. "The genes involved in biosynthesis and signaling of several hormones, specifically abscisic acid, were differently expressed."

The study later used genetic tests to clarify the role of abscisic acid using plants defective in biosynthesis genes – NCED3 and ABA2 – and by growing them under different light qualities, Krishna Reddy said.

Furthermore, the abundances of two hormones, abscisic acid and auxin, were determined in the axillary buds of plants treated with altered red to far-red ratio in order to understand the specific roles of these hormones in bud outgrowth process, said Holalu. This knowledge extends the known hormonal pathways associated with the regulation of branching and shade avoidance.

"Plant hormone abscisic acid can now be tied to the branching process and light signals where, reduction in red to far-red ratio suppresses axillary bud outgrowth due to elevated abscisic acid content in the buds," Finlayson said.

"Our results here support the earlier studies but extend them with genomic, biochemical and genetic evidences that abscisic acid acts as a regulator of branching and branching responses to the red to far-red ratio," he said.

He added that future studies will be directed towards developing ideal phenotypes in wheat, sorghum, forages and other commercial crops that are of interest to breeders, physiologists, agronomists and producers.

More information: www.plantphysiol.org/content/e … ly/2013/08/08/pp.113

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