Rooting regulators are evolutionarily conserved

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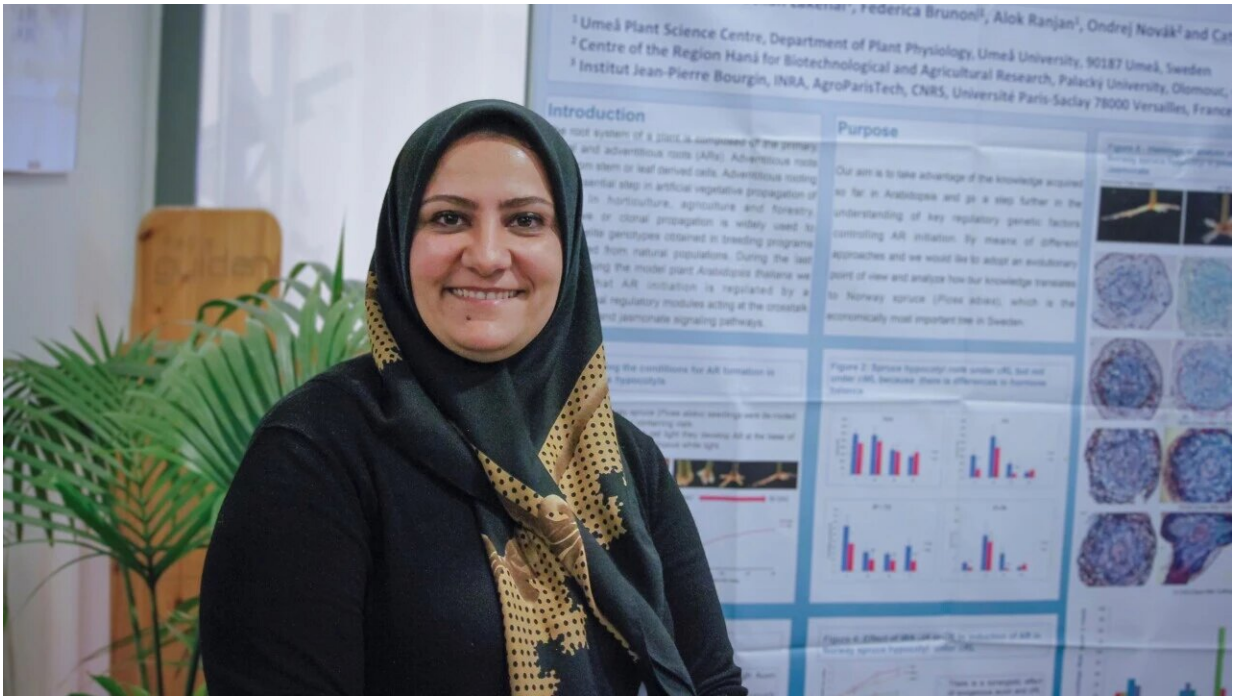

Sanaria Abbas Jaafer Alallaq, PhD student at Umeå Plant Science Centre, UPSC, Umeå University. Credit: Eva-Maria Diehl

Many plants can easily be regenerated and multiplied using cuttings. Crucial is that the cutting can initiate the formation of roots, a process called adventitious rooting. Sanaria Abbas Jaafer Alallaq showed in her Ph.D. thesis that some of the molecular regulators that control the initiation of adventitious roots in plants are similar in non-woody and

woody plants like Norway spruce and poplar. She will defend her Ph.D. thesis at Umeå University on Thursday 3 June.

Several economically and ecologically valuable tree species are difficult to multiply via cuttings because their cuttings do not form roots. Sanaria Abbas Jaafer Alallaq did her Ph.D. in Catherine Bellini's group at the Umeå Plant Science Centre and used the knowledge that her group and other researchers acquired with the non-woody plant thale cress.

She studied how this knowledge translates to the woody species Norway spruce and poplar. Her results demonstrated that the initiation of adventitious roots is regulated in Norway spruce seedlings and poplar cuttings in a similar manner like in thale cress—at least for the key regulatory factors light and the plant hormones, auxin, cytokinin and jasmonate.

"Adventitious root initiation is a complex developmental program governed by a plethora of external and internal factors including plant hormones and light. The exact molecular mechanisms underlying this process are still largely elusive especially with respect to trees," says Sanaria Abbas Jaafer Alallaq. "The recent availability of the reference genomes of some tree species such as Norway spruce or poplar make it possible to tackle adventitious root initiation from an evolutionary developmental perspective which we believed was a timely step."

For her experiments, Sanaria Abbas Jaafer Alallaq grew Norway spruce seedlings from seeds and removed the roots when they were three weeks old to see under which conditions, they regenerate adventitious roots. When kept under normal white light conditions, the de-rooted seedlings did not regenerate easily adventitious roots but under red light conditions, hundred percent of the seedlings rapidly developed adventitious roots.

Sanaria Abba Jaafer Alallaq and her colleagues analyzed the concentration of plant hormones in the cutting base of the de-rooted Norway spruce seedlings and found higher levels of the plant hormones cytokinin and jasmonate in the seedlings grown under white light conditions.

"These two plant hormones hinder the formation of adventitious roots also in thale cress while auxin is known to stimulate adventitious rooting," explains Sanaria Abbas Jaafer Alallaq. "We wanted to understand more how similar the regulation is on the molecular and genetic level. Norway spruce still has its limitations to do these studies even though its genome has been sequenced. That is why we included poplar in our studies which offers currently many more possibilities to study for example gene expression."

Sanaria Abbas Jaafer Alallaq compared hybrid poplar and hybrid aspen, two closely related poplar species with different ability to form adventitious roots. She took cuttings from three-month-old trees grown in the greenhouse and placed them in nutrient solution. The cuttings of hybrid poplar easily formed adventitious roots, while the hybrid aspen cuttings did not root under these conditions.

Sanaria Abbas Jaafer Alallaq analyzed the gene expression in the base of the cuttings and saw that many more genes were activated in hybrid poplar than in hybrid aspen. She identified many key genes that are involved in the regulation of auxin in hybrid poplar while genes involved in the biosynthesis of jasmonate were activated in hybrid aspen.

"This confirmed that also in poplar cuttings auxin and jasmonate have opposite effects on the initiation of adventitious roots and that at least some of the underlying regulatory mechanisms were conserved during evolution," says Sanaria Abbas Jaafer Alallaq. "These results from our basic research are small steps that hopefully help in future to improve

adventitious rooting of horticultural and forest species."

More information: Characterization of adventitious root formation in Populus species and Norway spruce. umu.diva-portal.org/smash/record.jsf?pid=diva2%3A1548864&dswid=9488

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