Geophysical Research Abstracts
Vol. 21, EGU2019-19207, 2019
EGU General Assembly 2019

The short-term response of growth, distribution and morphology of fine root to soil moisture gradient in young Populus tomentosa plantation

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Populus tomentosa is a dominant poplar species in North China. Clarifying the short-term response of fine roots to soil water gradient in the P. tomentosa plantation is helpful to have a better understanding on the ecological adaption strategy of plant roots to soil moisture. Three irrigation treatments were set in a two-year-old P. tomentosa stand planted on the sandy loam, i.e. full irrigation (DIFI), controlled irrigation (DICI), and control (CK). After 2 months of irrigation, root sampling down to 150 cm depth was conducted in each treatment using the soil core method. Through the measurement of root samples, the root growth, distribution and morphology data in each treatment, soil depth and horizontal distance were obtained. Vertically, in each soil layer, there is no significant difference in fine root biomass density (FRBD) among treatments ($p > 0.05$). In the whole root zone and the area with a large moisture difference in shallow soil layer among treatments, the distribution depth of fine root showed a characteristic of CK > DICI > DIFI. However, this characteristic was not observed in the area with less difference in soil water content. Horizontally, FRBD in CK decreased gradually with the increase of the distance from tree, but this trend was very weak in DIFI and DICI treatment. There was no significant difference of FRBD among treatments at each horizontal distance ($p > 0.05$), except for the distance of 30 cm from tree, where FRBD of CK was obviously higher than DIFI and DICI treatment ($p < 0.05$). On a two-dimensional scale, fine roots distribution tended to be shallower with the increasing distance from tree. Under irrigation, fine roots mainly concentrated in the shallow soil layers at both sides of the dripper, while a majority of fine roots in CK distributed in the relatively deeper soil layers close to the tree. For each soil layer within 0–50 cm, no significant difference in fine root morphology was found among treatments ($p > 0.05$). Both the variation of the total fine root biomass and length among the treatments followed an order of CK > DIFI > DICI. In conclusion, when a short-term moisture difference occurred in the shallow soil layers, 1) the fine roots of P. tomentosa distributed deeper and tended to concentrate closer to the tree with the aggravation of drought stress, 2) P. tomentosa preferentially adjusted the fine root distribution rather than the fine root morphology in the shallow soil layer to adapt to soil water stress, 3) as to the total amount of fine roots, P. tomentosa adopted a regulation strategy of slight decrease at first and then distinct increase.