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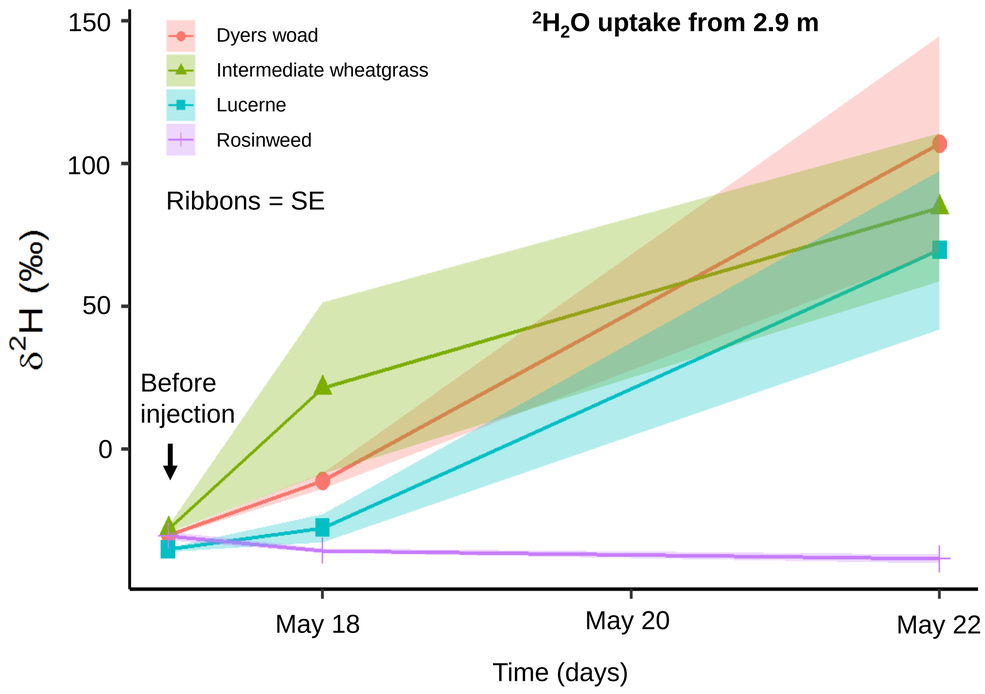
Capacity of Deep Rooted Species to Take Up Water and Nutrients from Deep Soil Layers

DeepFrontier - Exploring the Potential of Deep Roots

Are deep rooted species able to take up water and nutrients from soil layers from 2 – 4 m depth?

Agricultural cropping systems generally have a limited use of water and nutrients from the soil below 1 m depth. However, including deeper rooted species in cropping systems, might allow for exploitation of otherwise unused resources from deep soil layers.

Four different species were shown to have the capacity of water and nutrient uptake from around 3 m depth, but the amounts taken up was species specific.



Deep water uptake

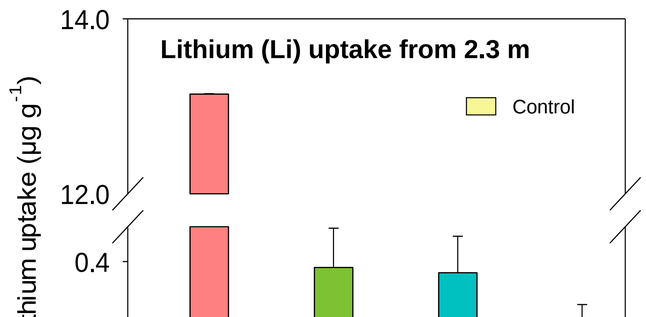
All species took up water from 2.9 m depth except for rosinweed, which had limited root growth in that depth. Water was taken up from deep soil layers, despite sufficient water being available in more shallow layers.

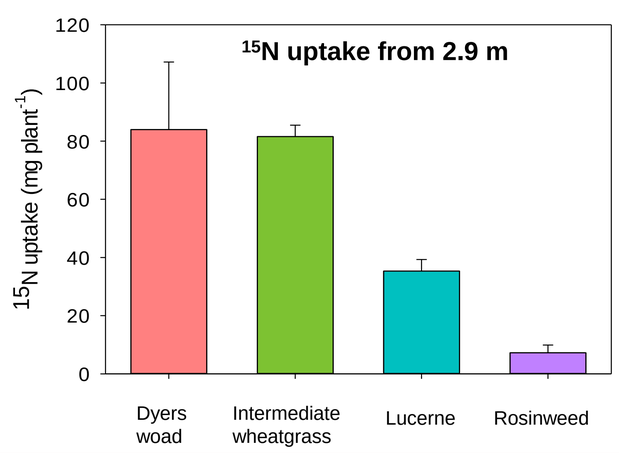
Water content sensors showed significant differences in the amount of water taken up by the different species from deep soil layers.

Lucerne used most of the available water down to 3.5 m depth, while intermediate wheatgrass used significantly less water despite similar aboveground biomass and rooting depth.

Nutrient tracers (Cs, Li, Se) were added to in-growth cores inserted at different depths (0.5 m, 2.3 m and 3.5 m) and isotopes of water (^2H_2O) and nitrogen ($^{15}NH_4Cl$) were injected in 2.9 m depth to determine the potential of deep root resource uptake. Plastic bags were used to collect the ^2H signal in the transpiration water.

A research facility consisting of 24 rhizotrons (4 m × 1.2 m × 0.3 m) was established to study root activity of plants grown in soil in a realistic scale. Four different deep-rooted species were grown in three replicates, dyers woad (*Isatis tinctoria*), intermediate wheatgrass (*Thinopyrum intermedium*), lucerne (*Medicago sativa*) and rosinweed (*Silphium integrifolium*).





Deep nutrient uptake

Nutrient uptake was found in 2.3 m of all species except for rosinweed.

Dyers woad took up nutrient tracers in the entire root zone including Se from 3.5 m depth.

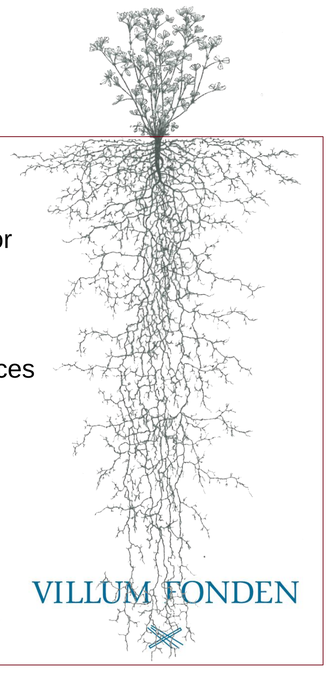
^{15}N was taken up in all species, mostly in dyers woad and intermediate wheatgrass, while the N uptake of lucerne was low as expected for legumes. Uptake in rosin weed was low as root growth was limited in that depth.

Uptake of the relatively immobile nutrient tracers seemed to be related to root biomass, while the mobile nitrogen isotope was less dependent on a high root biomass.

DeepFrontier

The DeepFrontier project is developing methods, facilities and ideas for future research into sustainable food production.

Our aim is to improve the understanding of deep rooting, i.e. what determines deep rooting, the activities of deep roots and which resources from deep soil layers are utilized by plants. The project will also study cropping systems with deep rooted species.



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