Root system responses of *D. glomerata* and *M. sativa* to water deficit in pure or mixed stands

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Introduction

It is estimated that climate change could lead to a shortage in summer precipitation of up to 25% in Belgium by 2100. Since forage crops represent almost 55% of Belgian agricultural land, it becomes obvious that grassland plants' reactions should be studied when facing those conditions. To tackle the issue, UCL launched the ForDrought project in 2012. Its objective is to improve forage cropping systems to face climate change.

Fig 1. Aerial view of the parcels of the Fordrought project. The plastic covers above the parcels enable to enforce a water deficit.

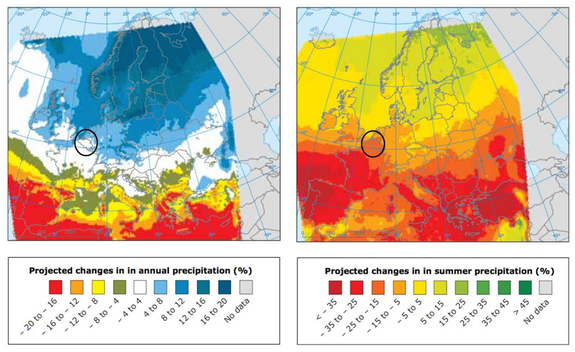


Fig 2. Projected changes in annual (left) and summer (right) precipitation (%) between 1961-1990 and 2071-2100. Belgium is surrounded with the black outline.

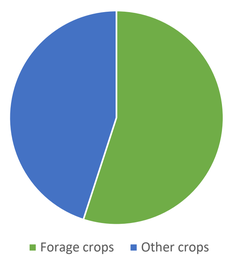


Fig 3: Importance of forage crops in Belgian agricultural land

Goal: Observe the plants' response mechanisms to water deficit

Material and Methods

A. Root countings

Fig 4. Digging of the pits in front of the parcels (left), placement of a grid (center), root countings in each cell of the grid (right). Each cell was a square of 2.5cm by 2.5cm. The measures were taken on a width of 1.5m and a depth of 1.5m.

B. Horizontal and vertical sampling

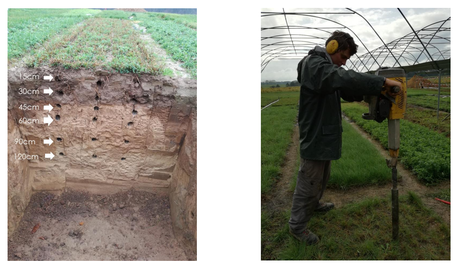


Fig 5. Position of the horizontal samples (left) and vertical sampling (right). The horizontal samples were taken at the depths indicated on the image and with 3 repetitions. The vertical samples were taken at the 4 corners of a square of 90cm of size.

C. Genetic analysis

Fig 7. The soil samples are washed in order to extract the roots. Those roots were weihted in order to know the root density in the soil.

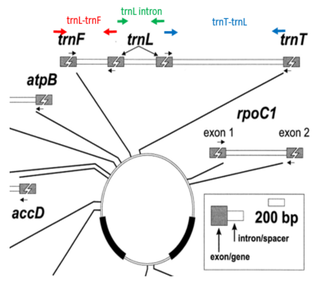


Fig 8. Three different primers were used to amplify specie-specific sections of the genomes of the roots (PCR)

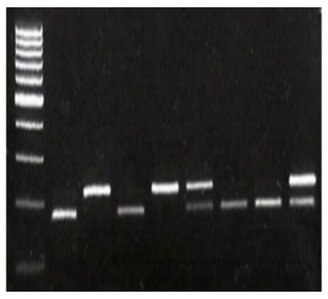


Fig 9. Detection of presence or absence of specie in sample using agarose gels

D. Yield

Fig 10. Harvest of one of the plots

Results

Clear differences in number of roots according to treatments and species

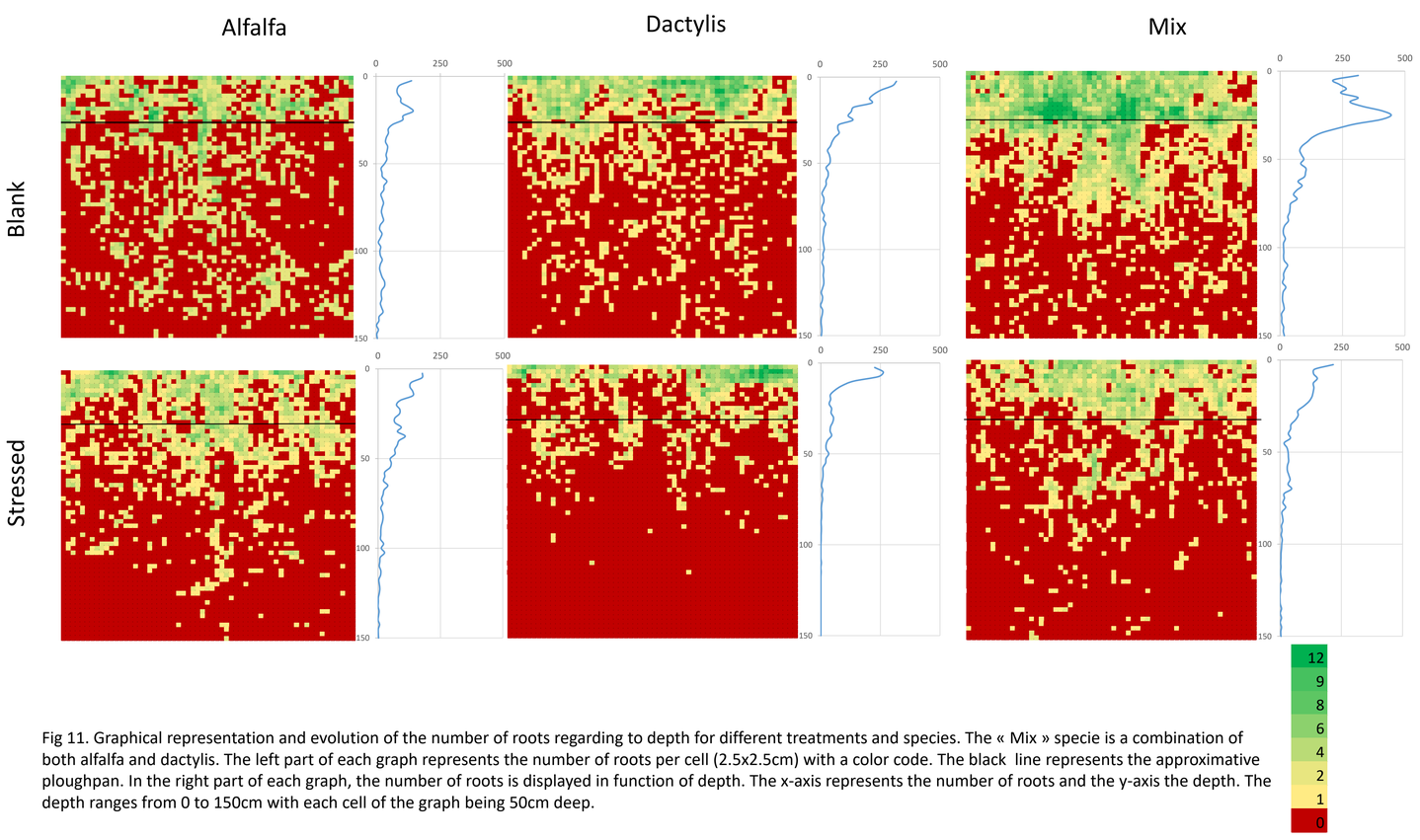
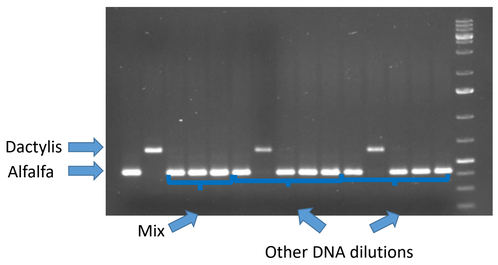


Fig 11. Graphical representation and evolution of the number of roots regarding to depth for different treatments and species. The « Mix » specie is a combination of both alfalfa and dactylis. The left part of each graph represents the number of roots per cell (2.5x2.5cm) with a color code. The black line represents the approximative ploughpan. In the right part of each graph, the number of roots is displayed in function of depth. The x-axis represents the number of roots and the y-axis the depth. The depth ranges from 0 to 150cm with each cell of the graph being 50cm deep.

Presence of Alfalfa in sample prevented detection of Dactylis



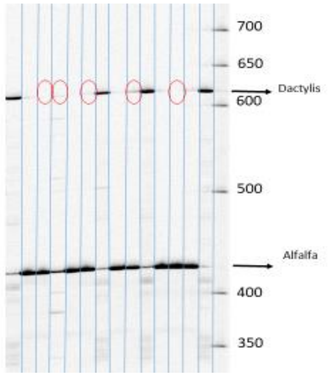


Fig 12. Acrylamid gel (top) and agarose gel (bottom) of the PCR amplification results of DNA fragments of Alfalfa, Dactylis and a mix of both species with different relative quantities of DNA in the mix. The red outlines in the bottom gel indicate spots where dactylis was present but not detected

Yield of blank plots was significantly higher than that of stressed plots at third harvest (at end of stress)

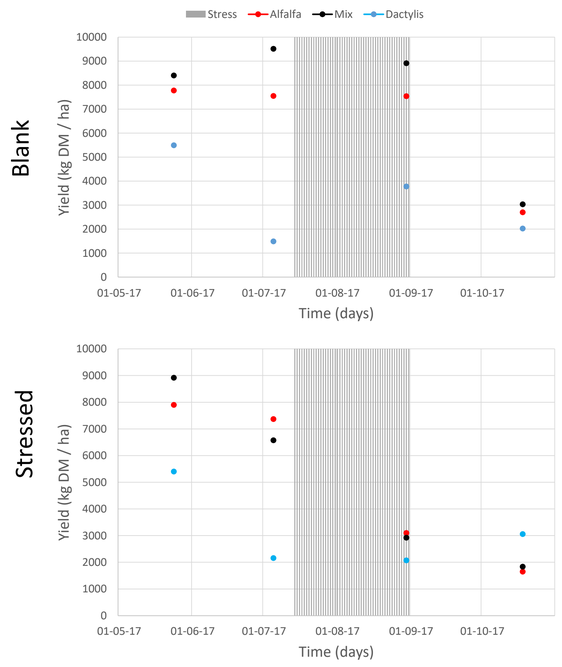


Fig 13. Yield evolution in function of time for blank and stressed plots. The gray zone in the graph represents the duration of the stress.

Conclusions

The number of roots is impacted by the stress but the different species react differently: Alfalfa produces more roots under stress while dactylis produces less.

The genetic analysis has shown that dactylis could not be detected when mixed with alfalfa.

Water deficit reduces the yield, while the impact of the association on the yield is less clear.

References:

(1) Taggart J.M., Cahill J.F., McNickle G.G., Hall J.C., (2011), Molecular identification of roots from a grassland community using size differences in fluorescently labelled PCR amplicons of three cpDNA regions: Molecular diagnostics and DNA taxonomy, Molecular Ecology Resources, 11,1, 185-195

(2) Robbins N.E., Dinneny J.R., (2015), The divining root: moisture-driven responses of roots at the micro- and macro-scale, Journal of Experimental Botany, 66, 8, 2145-2154

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