Root dynamics of weed species in relation to soil-nitrogen level:how to represent them ?

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ROOT DYNAMICS OF WEED SPECIES IN RELATION TO SOIL-NITROGEN LEVEL. HOW TO REPRESENT THEM?

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Introduction

In agroecosystems, the harmfulness of weed species depends on their competitive ability, i.e. their capacity to take up resources at the expense of crop species. Root architecture is known to play a key role in the competition for soil-resources between plants but, to date, little is known about the root architecture of weed species. Gaining such knowledge will be useful to better understand crop-weed competition and thereby to identify management practices that favour crop vs. weed growth in cropping systems with reduced reliance on herbicides. Among these practices, placing nitrogen (N) fertiliser on the sowing row or growing competitive crop cultivars are possible options. To analyse their benefits for weed regulation, a model-based approach is in progress. A simple model of root architecture (Pagès et al., 2014) was chosen due to its small number of parameters allowing to parametrize a large number of species for different processes related to root architecture (root emission, elongation and branching). The aim of this study was to identify which processes reflected by the parameters of the model are variables and, inversely, which of them are stable in a range of weed and crop species grown at contrasted soil-N levels.

Materials and Methods

Two greenhouse experiments were conducted on a panel of nine monocot and dicot annual weed species and three crop species, i.e. wheat, oilseed rape and pea. Plants of each species were grown individually in pots at two nitrate concentrations in the nutrient solution (0.625 vs. 10.5 mM). For each experiment, plants were harvested at three consecutive dates (2, 3 and 4 and 4, 6 and 8 weeks after sowing for experiments 1 and 2, respectively). Root systems were removed from the soil, then colored with blue of methylene and scanned (600 dpi resolution). Leaf, stem and root biomass were determined after 48h at 80°C. Images were analyzed to determine apical diameters, length, topology and distance between ramifications. From these measurements, parameters were estimated. As apical diameter is known to be correlated to the size of the apical meristem, apical diameter is a key variable in the model. Estimated parameters were (i) for primary root emission for monocots: the date from which the root number starts to increase and the rate of emission, (ii) for root branching: inter-branch distance, the slope of the relationship between daughter and mother root diameters, minimum and maximum root apical diameters and (iii) for root elongation: the slope of the relationship between root elongation rate and root apical diameter (Pagès et al., 2014).

Results and Discussion

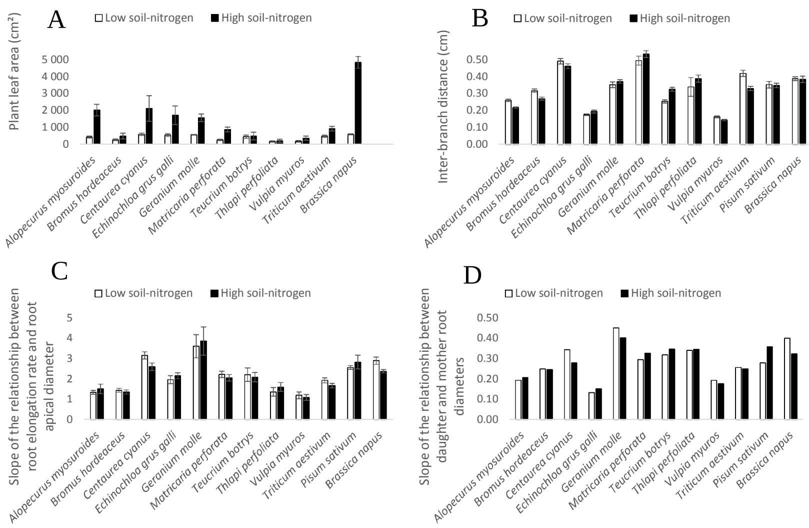

Figure 1. Plant leaf area and example of parameter values for the panel of species at two soil-N levels

Root biomass and leaf area (Fig.1A) differed among species ($P<0.001$) and between N treatments ($P<0.0077$; except for root biomass in Experiment 2 where $P=0.078$). For both variables, the species×N interaction was significant ($P<0.0124$). All the root parameters differed among species ($P<0.001$). Depending on the parameter, the impact of N was non-significant (e.g. inter-branch distance; Fig.1B) or significant but minor compared to the species effect (e.g. the slope of the relationship between root elongation rate and root apical diameter; Fig.1C) or detected via the species×N interaction only (e.g. the slope of the relationship between daughter and mother root diameters; Fig.1D).

Conclusions

The root parameters showed high differences among species while they were differentially affected by soil-N. The next step will be to couple the root architecture model to a model simulating the effects of cropping systems on weed demography.

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References

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