
Shifts in belowground interactions in a legume-cereal intercrop: a test of the Stress Gradient Hypothesis

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Abstract

According to the Stress Gradient Hypothesis, poor resource availability should favor positive interactions while high resource availability should lead to strong competition between plants relying on the same resources. While this hypothesis has been tested in natural ecosystems along "natural" abiotic stress gradients, it has never been done with crop species.

Here, we propose to adapt this theory to a more agronomic context, in which we aim to optimize positive interactions while maintaining a satisfying production. We present the results of a glasshouse experiment in which a cereal (wheat) and a legume (white lupin) are grown together or separately along two crossed gradients of phosphorus and nitrogen availability.

As white lupin, by exuding carboxylates, protons and phosphatases, can increase P bioavailability, and can also acquire N through the symbiotic fixation of dinitrogen, we hypothesise that the cereal could benefit from the presence of the legume in the most N- and P- limiting treatments.

We examine the relationships between N and P supply levels and the nature and strength of belowground interactions between wheat and white lupin. We also investigate the potential mechanisms explaining our observations, such as facilitation and niche complementarity processes. Overall, the most positive interactions are met in the most stressful treatments, but do not lead to the high expected production, suggesting the need to make compromises between ecological intensification and crop yield goals.

Keywords: belowground interactions, facilitation : niche complementarity, stress gradient hypothesis, nitrogen, phosphorus, legume, cereal

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