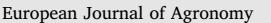
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## Nitrogen benefits of ten legume pre-crops for wheat assessed by field measurements and modelling



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ARTICLE INFO	A B S T R A C T
Keywords: Pre-crop effect Grain legumes Crop residues Mineralisation N leaching	The positive effect of grain legume pre-crops on the yield of the subsequent crop has been studied widely, whereas less information is available on the nitrogen (N) processes related to this positive effect, especially for a wide range of grain legume species. The objective was to quantify and understand the effect of grain legume compared to cereal pre-crops (sown in 2014 and 2016) on grain and shoot N yields and shoot N concentration of wheat ( <i>Triticum aestivum</i> ) grown the following year (2015 and 2017). Spring legumes (faba bean ( <i>Vicia faba</i> ), fenugreek ( <i>Trigolia foenum-graecum</i> ), common vetch ( <i>Vicia sativa</i> ), lentil ( <i>Lens culinaris</i> ), lupin ( <i>Lupinus albus</i> ), and pea ( <i>Pisium sativum</i> )) were compared to barley ( <i>Hordeum vulgare</i> ). Summer legumes (chickpea ( <i>Cicer arietinum</i> ), common bean ( <i>Phaseolus vulgaris</i> ), soybean ( <i>Glycine max</i> ) and Narbonne vetch ( <i>Vicia narbonensis</i> )) were compared to sorghum ( <i>Sorghum bicolor</i> ). Inorganic N remaining in the soil at pre-crop harvest (N sparing) was measured. The STICS model which accurately predicted soil humidity and soil inorganic N in the pedoclimatic conditions of the field experiments was used to calculate N mineralisation from pre-crop residues and N leaching between pre-crop harvest and wheat harvest. Grain and shoot N yields of unfertilised N wheat were respectively 27 and 25 % higher after faba bean and lentil compared to barley pre-crops, and 66 and 51 % higher after summer legumes compared to sorghum pre-crop. In the second experiment, N fertilisation reduced the positive effect of fenugreek, and lentil on wheat yield compared to summer pre-crops inducing higher N leaching after spring legumes pre-crops, specially in the first experiment which was characterised by heavy rain in summer and autum. Estimating N availability by taking into account N sparing, N mineralisation from soil and pre-crop residues and N leaching explained 49 % of wheat shoot N yield variability. Unquantified N processes and non-N processes might also have contributed to the posi

## 1. Introduction

Cereal crops generally have higher yields when cultivated after unrelated species (Kirkegaard et al., 2008) and especially after legume crops (Angus et al., 2015; Preissel et al., 2015). Some studies also highlighted higher grain N concentrations in cereals grown after legumes compared to cereals grown after cereals (Biederbeck et al., 1996; Gan et al., 2003). Part of the positive effect of legumes on the following cereals are due to N benefits.

Indeed, a substantial amount of N can be left by legume crop residues. Moreover, during crop residue decomposition by soil microbes, organic N is converted into inorganic forms that can be taken up by the subsequent crop. Much of the inorganic N released is rapidly immobilised by soil microbial biomass. Inorganic N accumulation in the soil occurs when the amounts of N released exceeds the microbial N requirements (net N mineralisation). Conversely, when inorganic N released from the mineralisation of crop residues is not sufficient, micro-organisms will also assimilate soil inorganic N to meet their N requirements, which results in net N immobilisation (Nicolardot et al., 2001). Net N mineralisation or smaller amounts of net N immobilisation are expected for legume residues compared to cereal residues, since legume residues are generally characterised by higher N concentrations and lower C:N ratios.

Furthermore, part of the additional soil inorganic N after legume

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