Is ‘durum wheat - winter pea intercropping’ efficient to improve the use of N in low-input farming?

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Background and objectives
- Intercropping (IC) can improve the use of environmental resources (light, nutrients and water) resulting in yield advantages and increasing yield stability compared to sole cropping (SC) (e.g. Willey, 1979).
- Corre-Hellou et al. (2006) demonstrated that spring barley-pea IC advantages were mainly based on:
  i) a better light use and ii) a deeper root growth of spring Barley vs. Pea leading to a more important soil N acquisition.
  → Yield and protein content of barley in IC relatively higher than in SC (e.g. Hauggaard-Nielsen et al., 2001 and 2003).
- No reference on winter crops IC was available, despite winter crops seems more adapted to conditions of southern Europe.
- Aim of our study: Evaluate the assumption that IC can improve protein content of durum wheat in low-input farming.
  i) Understanding competition between durum wheat and winter pea for N.
  ii) Analysing the consequences on shoot growth, N acquisition and grain protein content of durum wheat.

Material and Methods
- An experiment was carried out in Auzeville (SW France) in a clayed loamy soil. The two species were sown on the Nov. 8, 2005 in row-intercropping. The experiment was based on a split-split design with 3 replicates.
- Three main treatments were compared:
  i) W-SC: Durum wheat (cv. Nefer) sown at normal density (280 seeds/m²).
  ii) P-SC: Winter pea (cv. Lucy) sown at normal density (60 seeds/m²).
  iii) IC: Durum wheat-winter pea IC, each species sown at half of normal density.
- Three fertiliser-N sub-treatments were carried out:
  i) N0: No fertilizer; ii) N100: 2 applications of 50 kg N/ha; iii) N180: 3 applications of 30, 100 and 50 kg N/ha.
- Measurements made:
  i) Nitrogen status of SC and IC were evaluated by the Nitrogen Nutrition Index (NNI) and Nitrogen acquisition at harvest (N uptake) and the Grain Protein Concentration (GPC).
  ii) Land Equivalent Ratio (LER), defined as the relative land area under SC required to produce the yields achieved in IC and decomposed in partial LER (LERp) corresponding to each species (e.g. Hauggaard-Nielsen and Jensen, 2001).

Results
- NNI of durum wheat was significantly increased in IC than SC (Tab. 1).
- N uptake of durum wheat per m² was higher in SC but lower than the whole N acquisition of IC for N0 and N100 treatments (Fig. 1).
  → Greater wheat N uptake coming from soil mineral N.
- GPC of durum wheat was greater in IC for N0 and N100 (Tab. 2).
- Complementary use of soil N and symbiotic N2 fixation sources in IC.
- LER values were always higher than 1 (Tab. 3).
- Environmental resources were used 8 to 23% more efficiently in IC: the less N availability, the highest LER.
- LERp of wheat were always greater than pea and higher than 0.5 (Tab. 3).
- Wheat took advantage of IC by using resources more efficiently than pea.

Conclusions
- The ‘durum wheat - winter pea intercropping’ seems well adapted to the conditions of Southern France because it allowed:
  i) a better use of N resources (and light) during winter and early spring period of growing season
  ii) a higher grain protein concentration of durum wheat at harvest
- IC advantages were greater for the unfertilized treatment confirming the interest of intercropping in low-input farming