



**HAL**  
open science

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

Laurent Bedoussac, Eric Justes

### ► To cite this version:

Laurent Bedoussac, Eric Justes. Is durum wheat-winter pea intercropping efficient to improve the use of N in low input farming?. 15th Nitrogen Workshop, Towards a better efficiency in N use, May 2007, Lérída, Spain. pp.0. hal-04044892


**HAL Id: hal-04044892**

**<https://hal.science/hal-04044892>**

Submitted on 24 Mar 2023

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

A photograph of a butterfly with orange and black wings perched on a long, green leaf against a clear blue sky.


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

***Laurent BEDOUSSAC and Eric JUSTES***

INRA, UMR 1248 AGIR, TOULOUSE, France

E-mail: [Laurent.Bedoussac@toulouse.inra.fr](mailto:Laurent.Bedoussac@toulouse.inra.fr)

# Background and Objectives

- 
- **Intercropping (IC)** can be defined as the growing of two or more crops simultaneously in the same field during a growing season (e.g. Willey, 1979)
  - **IC** is known to improve the use of available resources (light, nutrients and water) and to increase **yield and its stability** between years compared to **sole cropping (SC)** (e.g. Willey, 1979)
  - Corre-Hellou et al. (2006) demonstrated that spring barley-pea IC leads to a more important soil N acquisition based on:
    - i) *a better light use*
    - ii) *a deeper root growth of spring Barley vs. spring Pea*
  - **Yield and protein content of barley in IC relatively higher than in SC**
  - 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) *Understand competition between durum wheat and winter pea*
    - ii) *Analyse the consequences of IC on shoot growth, N acquisition and grain protein content of durum wheat (quality criteria)*

# Material and Methods

- Experiment in Auzeville (SW France) in a clayed loamy soil
- The two species were sown the Nov. 8, 2005 in **row-intercropping**
- The experiment was based on a **split-plot design** with **3 replicates**

## **Three main treatments were compared:**

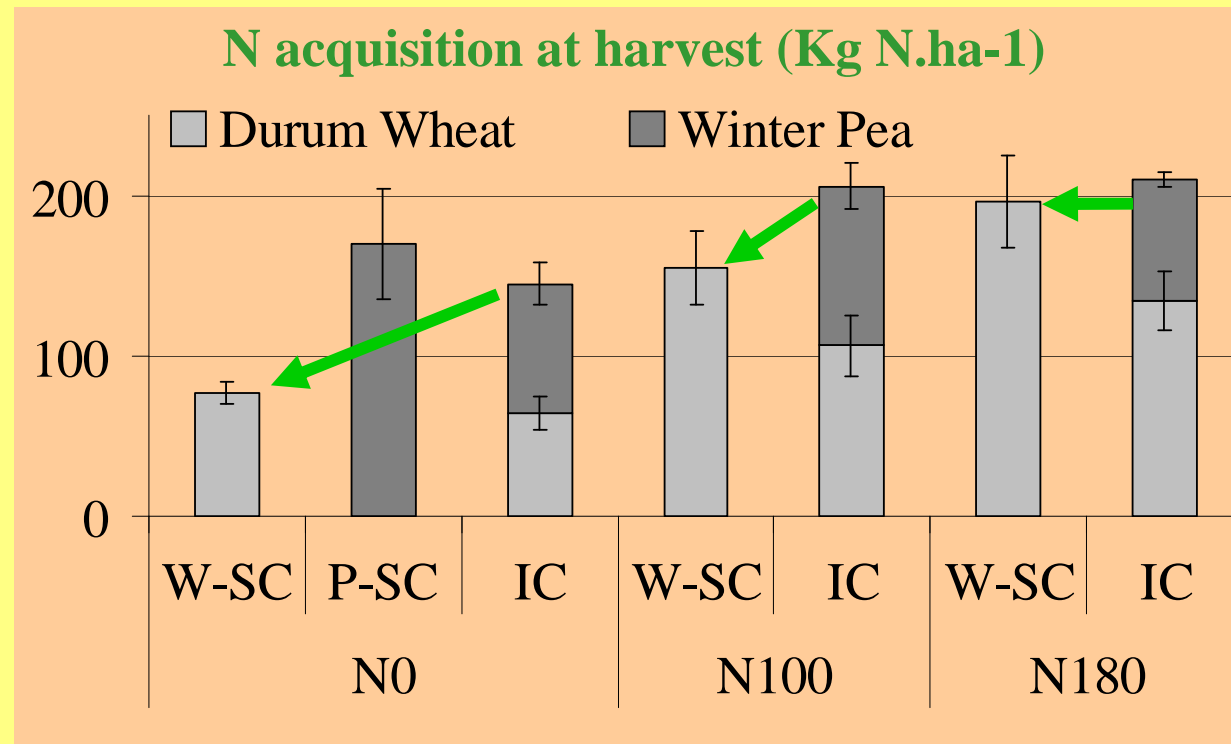
- W-SC:** Durum wheat (cv. Nefer) sown at normal density
- P-SC:** Winter pea (cv. Lucy) sown at normal density
- IC:** Durum wheat-winter pea IC, **each specie sown at half of SC density**

## **Three fertiliser-N sub-treatments were carried out:**

- N0:** No fertilizer
- N100:** 100 kg N/ha split into 2 applications of 50 kg N/ha
- N180:** in 3 applications of 30, 100 and 50 kg N/ha

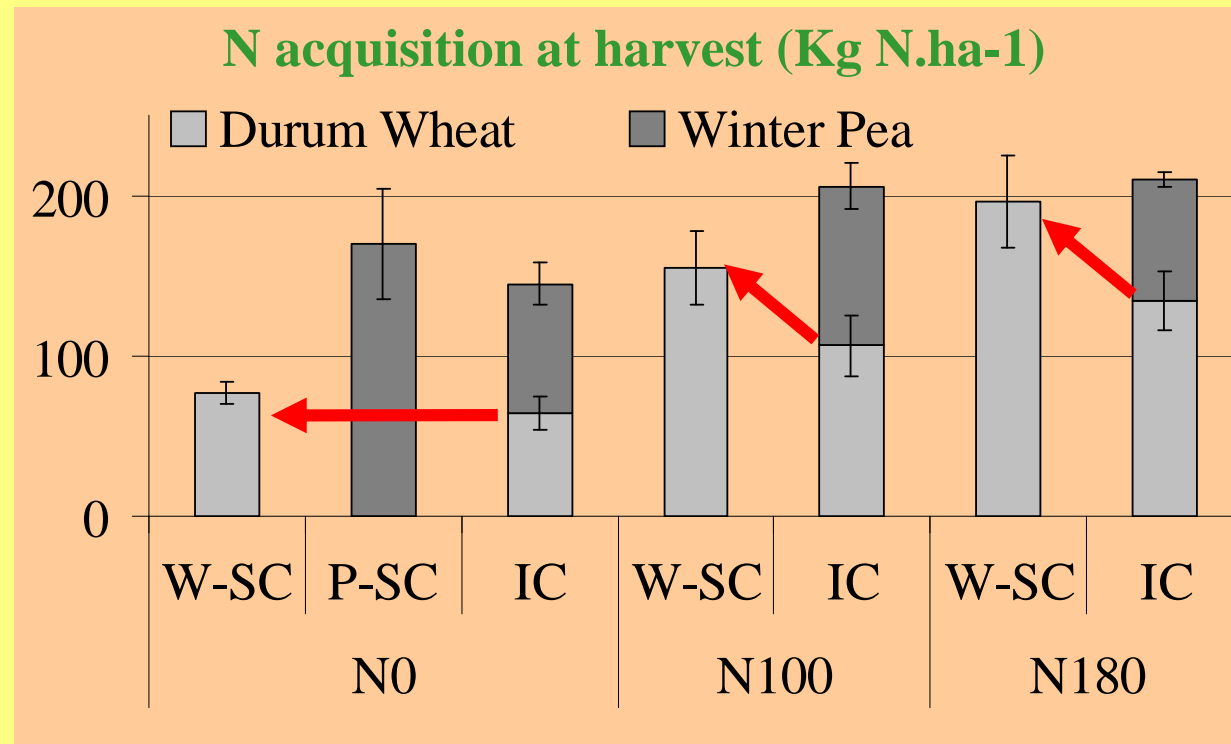


# IC increased nitrogen acquisition at harvest



- As well known wheat N acquisition increased with N fertilizer in SC even also in IC
- Moreover as expected, **the whole N acquisition of IC was better than wheat SC** (excepted for N180) due to N<sub>2</sub> fixation of pea

# IC increased nitrogen acquisition at harvest



- N acquisition of durum wheat per m<sup>2</sup> significantly **greater in SC than in IC.**
  - However the **N acquisition difference was lower than half of the wheat SC N acquisition.**
- **Greater N acquisition per wheat plant in IC vs. SC**

# IC increased wheat N Status (NNI)

## Durum wheat Nitrogen Nutrition Index (NNI)

Stage	N	W-SC	W-IC
142 DAS	N0/N100	0.49 (0.05)	0.56 (0.04)
Ear 1 cm of Wheat	N180	0.63 (0.04)	0.74 (0.03)
169 DAS	N0	0.40 (0.02)	0.50 (0.03)
Begining of Pea	N100	0.54 (0.04)	0.63 (0.08)
Flowering	N180	0.82 (0.04)	0.82 (0.04)
189 DAS	N0	0.35 (0.02)	0.45 (0.04)
Wheat Flowering	N100	0.58 (0.04)	0.71 (0.08)
	N180	0.74 (0.01)	0.76 (0.02)

- **NNI of durum wheat** was significantly increased in IC vs. SC throughout crop cycle

# IC increased wheat N Status (NNI)

## Durum wheat Nitrogen Nutrition Index (NNI)

Stage	N	W-SC	W-IC
142 DAS	N0/N100	0.49 (0.05)	0.56 (0.04)
Ear 1 cm of Wheat	N180	0.63 (0.04)	0.74 (0.03)
169 DAS	N0	0.40 (0.02)	0.50 (0.03)
Begining of Pea	N100	0.54 (0.04)	0.63 (0.08)
Flowering	N180	0.82 (0.04)	0.82 (0.04)
189 DAS	N0	0.35 (0.02)	0.45 (0.04)
Wheat Flowering	N100	0.58 (0.04)	0.71 (0.08)
	N180	0.74 (0.01)	0.76 (0.02)

- **NNI of durum wheat** was significantly increased in IC vs. SC throughout crop cycle
- **No effect for N180** because N fertilizer increased wheat growth, reduced pea DM (light) and reduced N<sub>2</sub> fixation of pea
- **Greater N uptake of soil mineral N per plant of wheat**
- **Complementary use of soil N and N<sub>2</sub> fixation in IC**



# IC improved the use of resources

**Land Equivalent Ratio** = relative land area under SC required to produce the yields achieved in IC. LER is decomposed in partial LER (**LER<sub>p</sub>**) for each specie as an indicator of their performance in IC (e.g. Willey, 1979)

## Land Equivalent Ratio (LER)

N	LER <sub>p</sub> P	LER <sub>p</sub> W	LER
N0	0.51 (0.09)	0.72 (0.10)	1.23 (0.18)
N100	0.59 (0.03)*	0.60 (0.10)	1.19 (0.11)
N180	0.38 (0.00)*	0.70 (0.13)	1.08 (0.13)

\*: In comparison to N0 treatment

- Land Equivalent Ratio **always higher than 1**  
→ Resources (light, C, N, water) were used 8 to 23% more efficiently in IC

# IC improved the use of resources

**Land Equivalent Ratio** = relative land area under SC required to produce the yields achieved in IC. LER is decomposed in partial LER (**LER<sub>p</sub>**) for each specie as an indicator of their performance in IC (e.g. Willey, 1979)

## Land Equivalent Ratio (LER)

N	LER <sub>p</sub> P	LER <sub>p</sub> W	LER
N0	0.51 (0.09) <	0.72 (0.10)	1.23 (0.18)
N100	0.59 (0.03) * =	0.60 (0.10)	1.19 (0.11)
N180	0.38 (0.00) * <	0.70 (0.13)	1.08 (0.13)

\*: In comparison to N0 treatment

- Land Equivalent Ratio **always higher than 1**  
→ Resources (light, C, N, water) were used 8 to 23% more efficiently in IC
- Partial LER of wheat always > 0.5 and > than pea LER<sub>p</sub>  
→ Wheat took advantage of IC by using available resources more efficiently than pea

# IC improved Grain Protein Content

## Grain Protein Concentration (% of DM)

N	W-SC		W-IC
N0	8.1 (0.3)	<<	10.7 (1.4)
N100	13.1 (0.3)	<	14.0 (0.7)
N180	13.6 (0.9)	=	13.4 (0.8)

- **Grain Protein Concentration** of durum wheat was greatly increased in IC for N0 and N100
  - This was probably **due to the higher N uptake per plant** (fertile tiller) and then per wheat ear
  - **Then, the lower N availability, the higher increase in GPC**
- **Intercrop seems more adapted to low input systems**



# 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) an increase in grain protein concentration of durum wheat*
- IC advantages were greater for the unfertilized treatment **confirming the interest of intercropping in low-input farming**
- **However** it is necessary to precise that IC performance depends on:
  - i) The complementarity of the two species:*
    - Growth dynamics (earliness, Nitrogen requirements)
    - Aerial structure (height, LAI, spatial leaf distribution)
  - ii) Cultural operations:*
    - N availability (proportion of the 2 species and N Status)  
→ final effect on Yield and Grain Protein Concentration
    - Date of sowing and plant density of the 2 species
  - iii) Soil and climatic conditions*
    - Needs for work on cropping sequence optimization
    - The next step of this work is to propose a dynamic crop-model simulating IC functioning in order to improve IC-management



# Thank you for your attention

Durum wheat (280 seeds/m<sup>2</sup>)



Winter pea (60 seeds/m<sup>2</sup>)



## Intercropping



Durum wheat (140 seeds/m<sup>2</sup>)



Winter pea (30 seeds/m<sup>2</sup>)

