Reducing biotic stress in grain legumes through intercropping with durum wheat ?

Laurent Bedoussac, Etienne-Pascal Journet and Eric Justes

laurent.bedoussac@toulouse.inra.fr - etienne-pascal.journet@toulouse.inra.fr



BACKGROUND & OBJECTIVES

- Legume pests and diseases are often a major concern, particularly in low inputs systems with few or no pesticide (organic) treatments.
- Intercropping (IC) - growing simultaneously two or more species in a same field - can lead to a significant reduction in weeds, harmful insects and diseases (e.g.[1-4]).
- However, IC efficiency in reducing such biotic stress has been controversial [5,6].
- Few references on winter crops IC available

- **Aim of this study** : evaluate the assumption that increasing planned biodiversity through intercropping of winter grain legumes with durum wheat can reduce legume pests (green aphids, pea leaf weevils…), weeds and diseases (ascochyta and faba bean rust…)

1 : Vandermeer 1989. Cambridge University Press; 2 : Trenbath 1993. Field Crop Res 34:381-405; 3 : Altieri 1999. Agric Ecosyst Envir 74:19-31; 4 :Kinane and Lyngkjaer 2002. Plant Protection Science 38:227-231; 5: Letourneau et al. 2011. Ecol Applic, 21:9–21; 6: Lithourgidis et al. 2011. Austr J Crop Sci, 21:9–21



MATERIAL AND METHODS

- Field experiments (winter crops) have been carried out in SW France since 2006

TREATMENTS:

- Durum wheat (2 cultivars), winter pea (cv. Lucy) and faba bean (cv. Castel) were evaluated as sole crops (SC), half density sole crops (SC1/2), and row- or mixed-intercropping (IC) replacement design with/whithout fertiliser-N supply or chemical pest management.

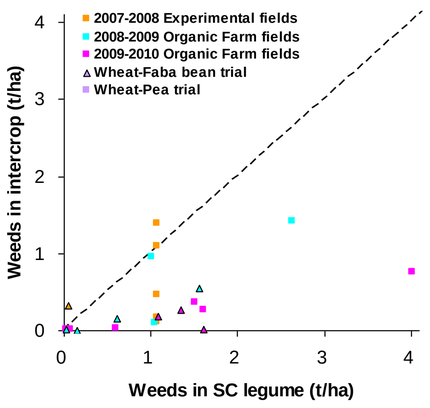
MONITORING CROP AND BIOTIC STRESS DYNAMICS:

- **Agronomic variables and indices:** crop height, morphology and phenology, leaf area, soil cover rate, dry biomass and accumulated N, grain yield and yield components, %N derived from N_2 fixation, Land Equivalent Ratio …
- **Time-course monitoring of weeds, pests & diseases populations / injury symptoms**



RESULTS

Weeds

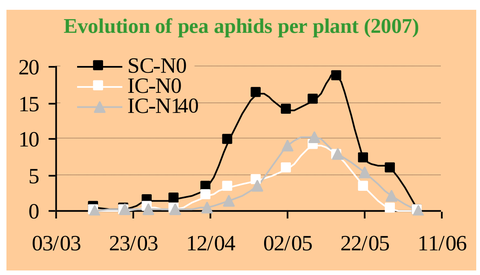


•Legumes less competitive than wheat for weeds
• IC efficient compared to SC legume (65% less weeds)
• IC not efficient compared to SC wheat (54%more weeds)

➔ Weeds reduction in IC mostly due to wheat because :
- Lower inter-row compared to SC faba bean
- Earlier growth compared to winter pea
- Species complementarity for light interception

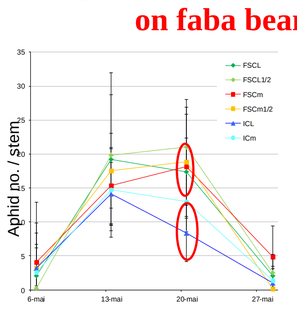
(see also Hauggaard-Nielsen et al 2001, Corre-Hellou et al, 2011)

Pea aphids (*Acyrthosiphon pisum*)



•Small number of pea aphids (2007)
•Less pea aphids in IC
•No difference between N treatments
➔ IC efficient to reduce pea aphids
Hypotheses: Physical barrier of wheat ? / Habitat modification? / Plant recognition ?

Megoura viciae aphids on faba bean



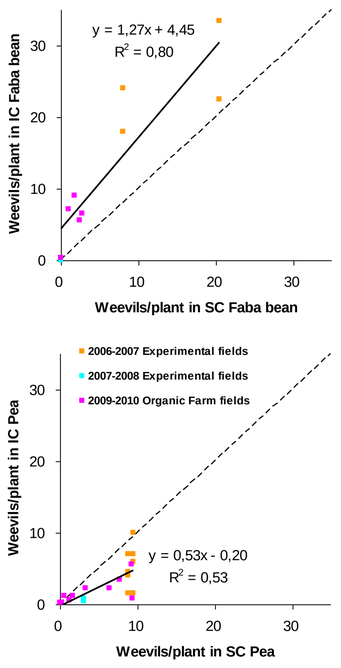




•Less aphids in IC (2011)
•Decrease of aphid population significantly earlier in IC
➔ IC efficient to reduce aphids in later phase
Similar hypotheses as above

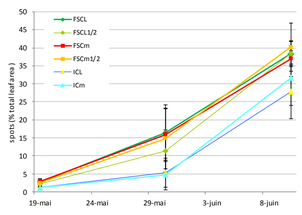
Pea leaf weevils





•More weevils on Faba bean than on Pea
• IC reduces weevils compared to SC pea (52% less)
• IC increases weevils compared to SC faba bean (95% more)
➔Faba bean more attractive than Pea ?
➔More Faba bean ressources due to higher dry weight than Pea ?
➔ Pea more difficult to be found in IC because smaller than wheat ?
➔Greater mobility/adaptability of weevils to a large range of habitats ?

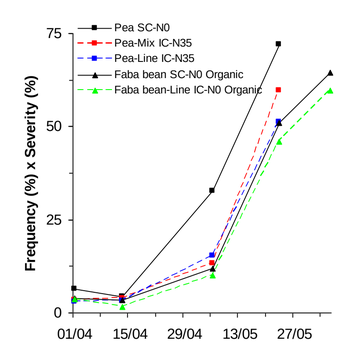
Faba bean rust (*Uromyces fabae*)





•Slower development of disease early phase symptoms in IC
➔IC efficient to reduce faba bean rust
➔Barrier effect to propagation, microclimate modification, lower biomass ?

Ascochyta (*Ascochyta fabae* / *Mycosphaerella pinodes*)



• Ascochyta reduced in IC for pea, not for faba bean
• Ascochyta developed earlier in Pea

➔ IC efficient to reduce ascochyta in pea
➔Barrier effect to propagation, microclimate modification, lower biomass ?

CONCLUSIONS

Our preliminary results further document the contrasting effects of IC against various pests due to interactions between plant architecture, disease dispersion, insect behaviour and farming practices :

- weeds were always reduced in IC compared to legume SC but not compared to wheat SC;
- pea aphids were significantly reduced in IC while weevils were not or slightly affected;
- diseases were mostly reduced in IC or at the same level as in SC and rarely increased.

Durum wheat-winter pea/faba bean intercropping thus seems efficient in reducing some diseases and pests through potential environmental modifications (resources dilution, physical barrier, microclimate shift…) resulting from contrasts between functional groups of species .

IC could therefore be a way to reduce the use of pesticides.

Prospects

- Further knowledge needed for designing intercropped species / cultivar assembly rules and management systems to reduce weeds, pests and diseases incidence / harmfulness
- Which are the best-adapted species and cultivars ?
- Effect of sowing densities and sowing patterns ?
- Model/simulate epidemics and injury profiles
- Landscape scale to be considered in a number of situations

UMR1248 AGIR
Chemin de Borde Rouge
INRA, CS 52627
31326 Castanet Tolosan Cedex
France