

Is P acquisition facilitated by intercropping of durum wheat and grain legumes in field conditions ?

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Plurespecific agroecosystems to face future nutrient scarcity?

In a *world of declining renewable resources*
for agricultural production as P and N (Vance 2001, Galloway, 2008 ; Cordell et al. 2009)

Context

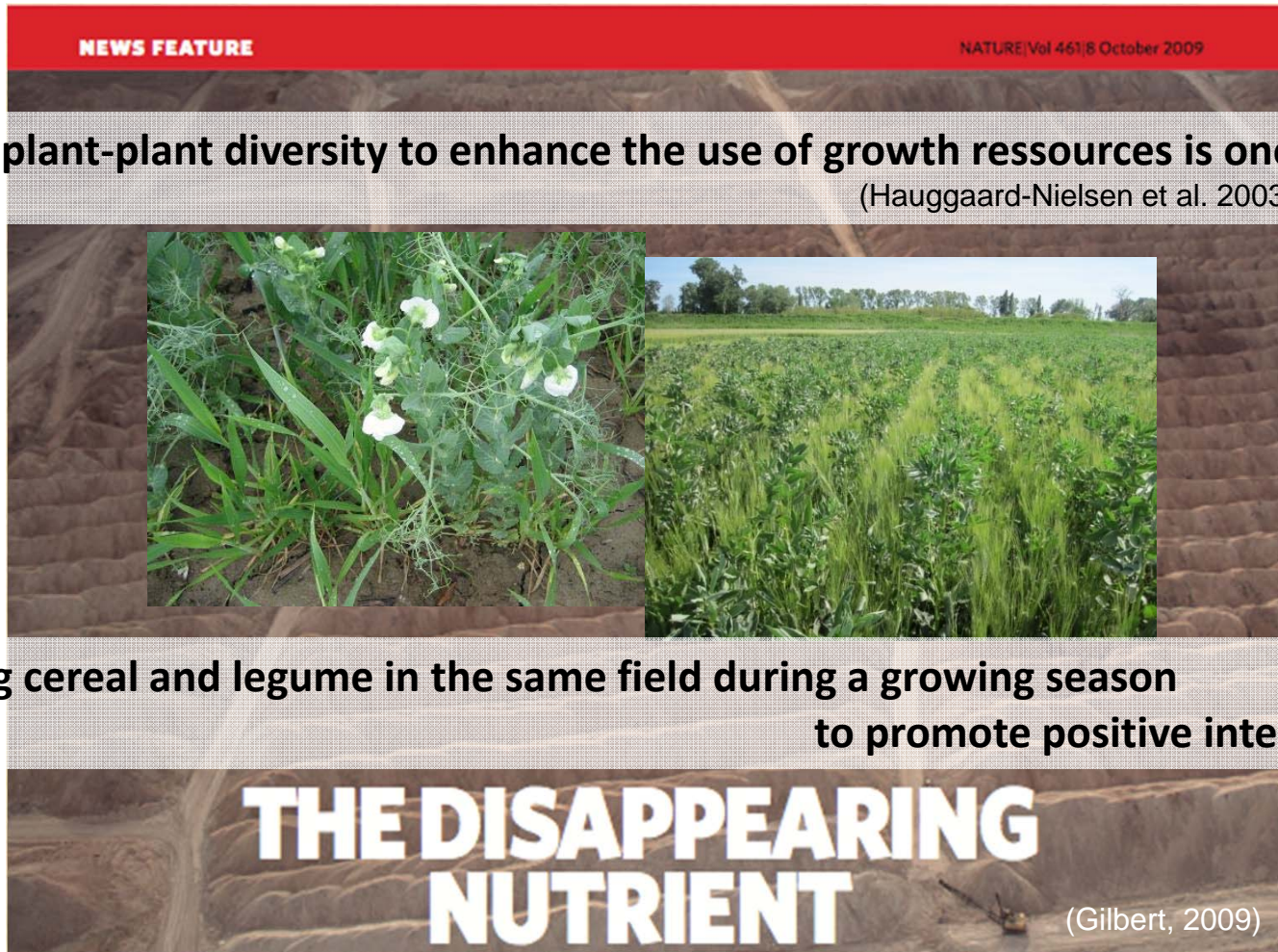
Objective & Strategy

Results & discussion

Conclusion

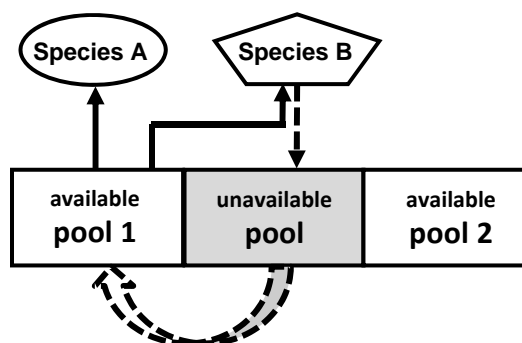
Using plant-plant diversity to enhance the use of growth resources is one solution

(Hauggaard-Nielsen et al. 2003 ; Li et al. 2007)



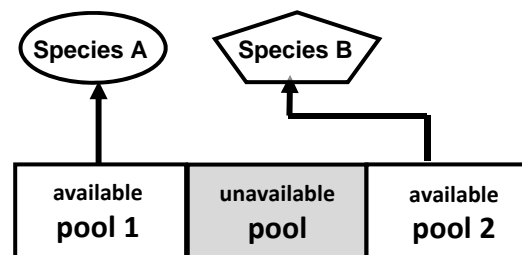
Plant-plant interactions in agroecosystems : processes from ecology science

Context



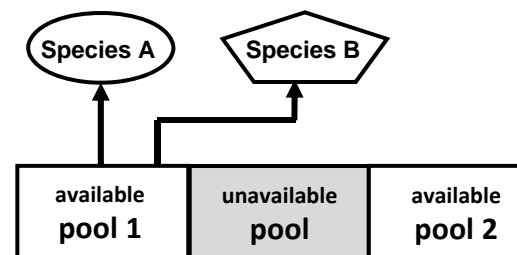
positive interactions
e.g. facilitation

Objective
&
Strategy



positive interactions
e.g. niche complementarity

Results
&
discussion



negative interactions
= competition

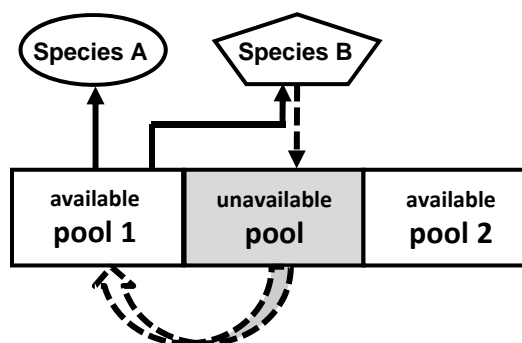
Conclusion

Resource partitioning and plant-plant interactions in intercropping systems

(Hinsinger et al. 2011 – Plant Physiol. Phosphorus Focus Issue)

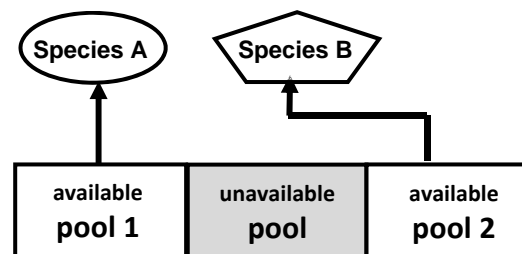
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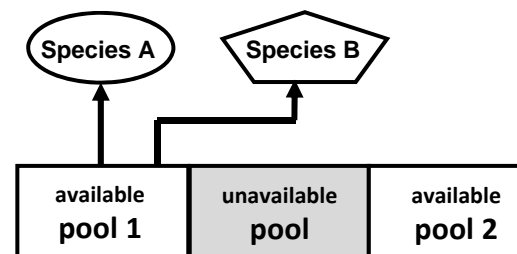
positive interactions
e.g. facilitation

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&
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positive interactions
e.g. niche complementarity

Results
&
discussion



negative interactions
= competition

low

ressource availability


high

Conclusion

Resource partitioning and plant-plant interactions in intercropping systems
and the « stress gradient hypothesis »

(Hinsinger et al. 2011 – Plant Physiol. Phosphorus Focus Issue)

Objective of the study



Test whether positive interactions occur in intercrops under field conditions across a soil P availability gradient

Context

**Objective
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Results
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Field experiment : site description

INRA long-term P fertiliser trial in Toulouse

Colomb et al. 2007 – *Eur. J. Agron.*

Context

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a unique soil P availability
gradient

Deep alluvial soil

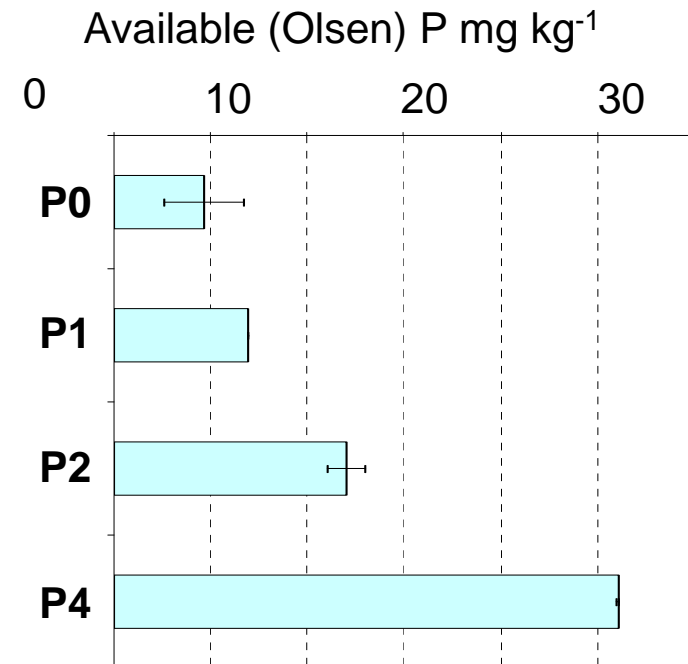
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INRA Toulouse-Auzeville

- 4 P levels :
- **P0** : no P applied since 1969
 - **P1** : 11 kg P ha⁻¹ yr⁻¹
 - **P2** : 22 kg P ha⁻¹ yr⁻¹
 - **P4** : 33 kg P ha⁻¹ yr⁻¹

4 replicates (blocks)



Field experiment : measurments

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Compare durum wheat and faba bean grown as sole crop (SC) or intercropped (IC)

- biomass
 - P acquisition
 - N₂ fixation
 - grain yield
- at various growth stages

a substitutive experimental design

intercrops were sown at half density of those in sole crops



Conclusion



Is P acquisition facilitated by intercropping of durum wheat and grain legumes in field conditions ?

Index of intercrop performance : LER – Land Equivalent Ratio

e.g. for biomass (DW – Dry Weights)

$$LER = DW_{IC \text{ cereal}} / DW_{SC \text{ cereal}} + DW_{IC \text{ legume}} / DW_{SC \text{ legume}}$$

LER > 1 → intercrop performs better than sole crops

$$LER = LER_{\text{cereal}} + LER_{\text{legume}}$$

Partial LER enable to evaluate the performance of each plant species

Partial LER > 0.5 → the species benefits from positive interaction

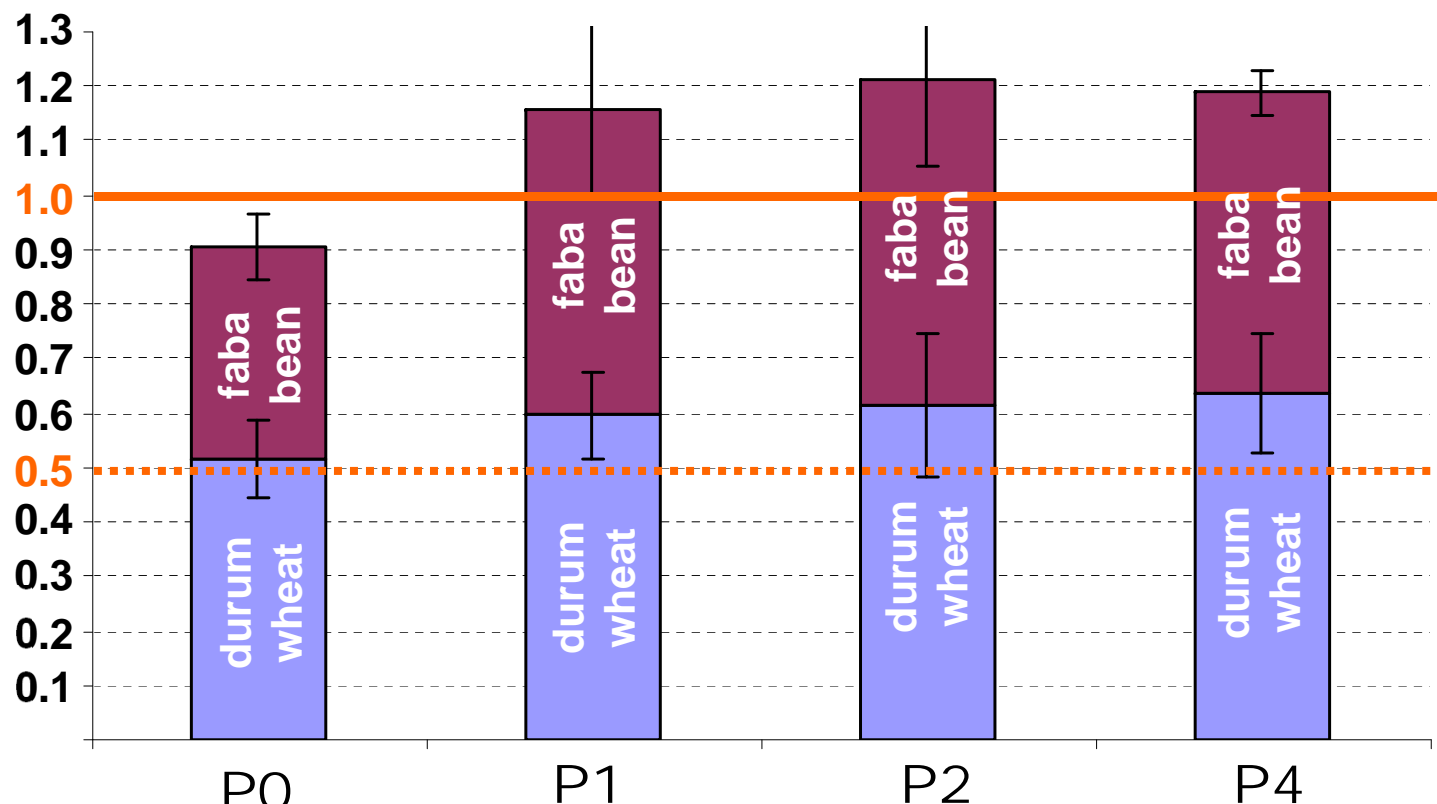
Partial LER < 0.5 → the species suffers from competition



Harvest and intercrop effect on yield

Grain yield

LER



P0
LER < 1

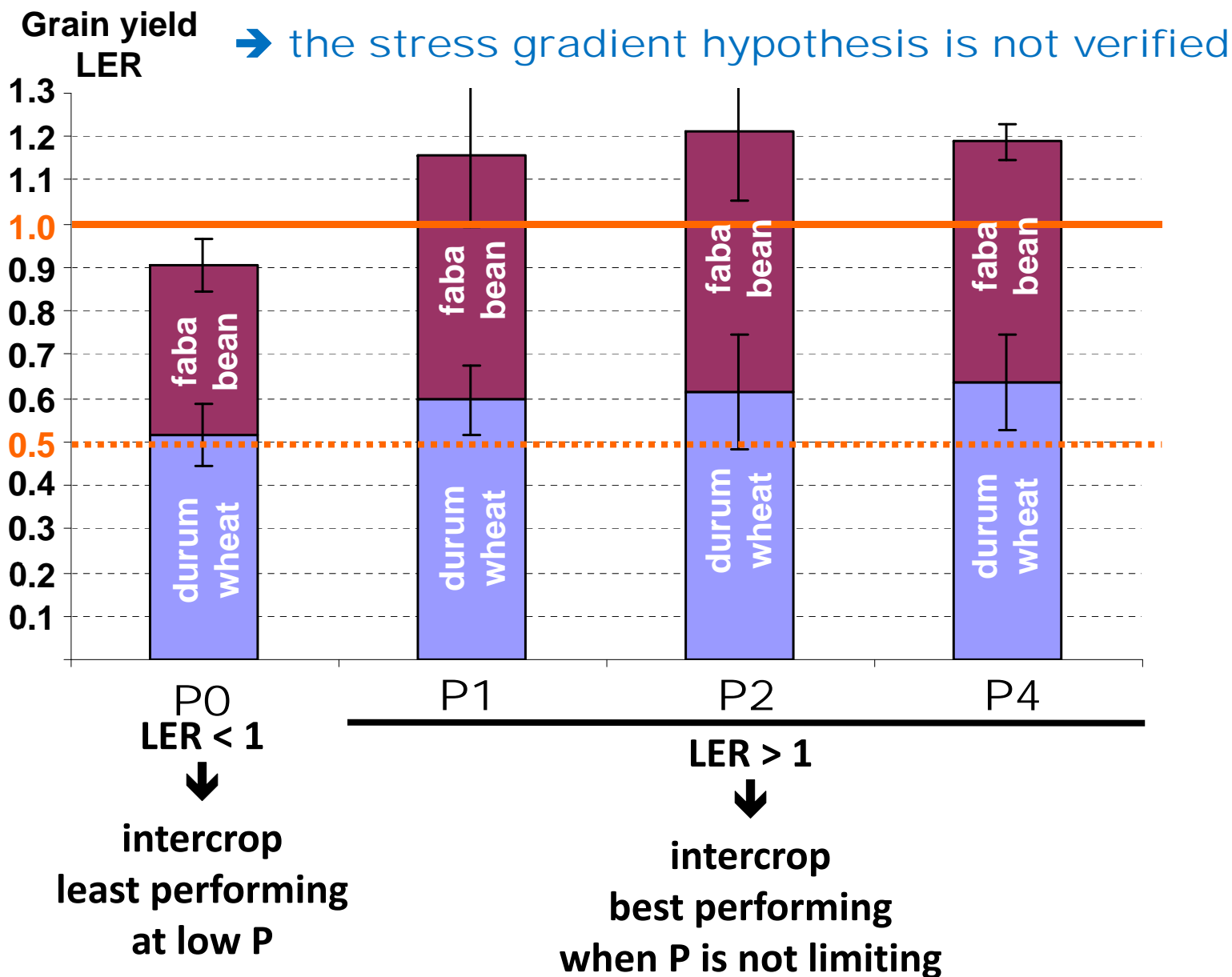


intercrop
least performing
at low P

→ the legume suffers competition at low P
partial LER_{faba bean} < 0.5

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Harvest and intercrop effect on yield



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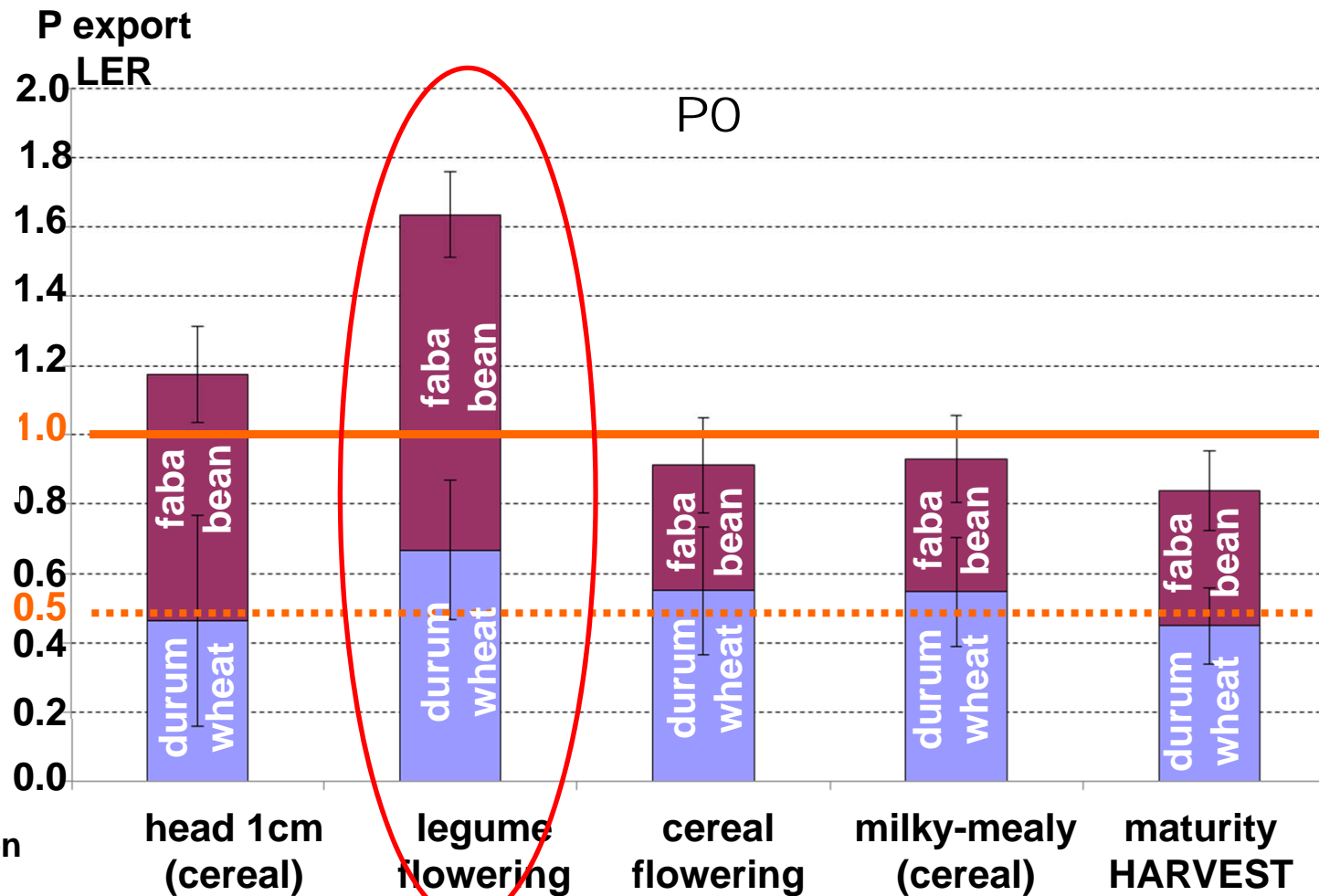
P export during crop growth

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Conclusions



LER > 1
↓
intercrop
best performing

→ positive interactions dominate
only at early stages of growth at low P
and peaks at legume flowering
(relative to high N₂ fixation activity stage)

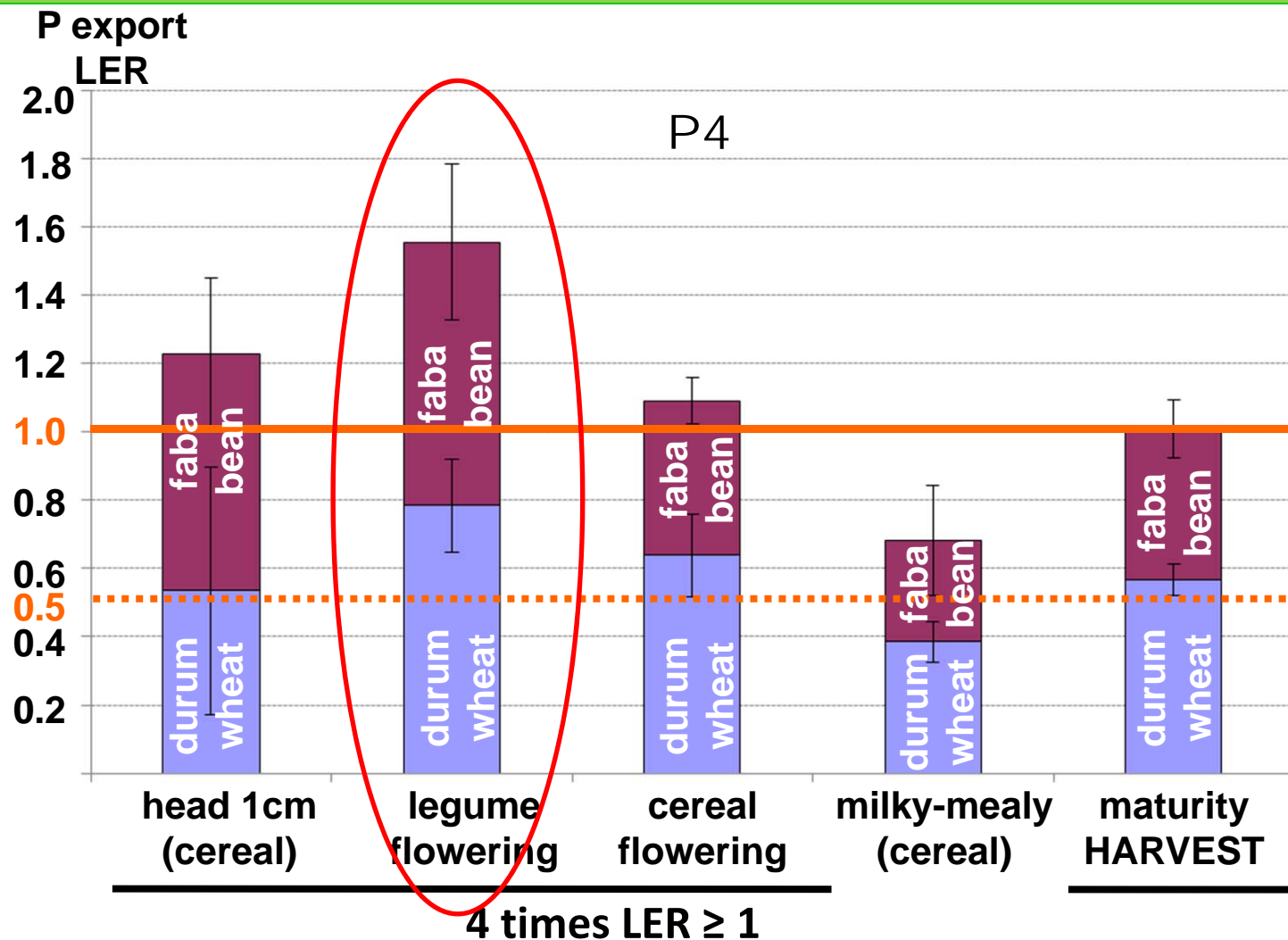
P export during crop growth

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→ positive interactions occur **more often** at high P
but dominate **only at early stages of growth**
and peaks at legume flowering (high N₂ fixation activity stage)

Shoot P concentration at legume flowering

Context

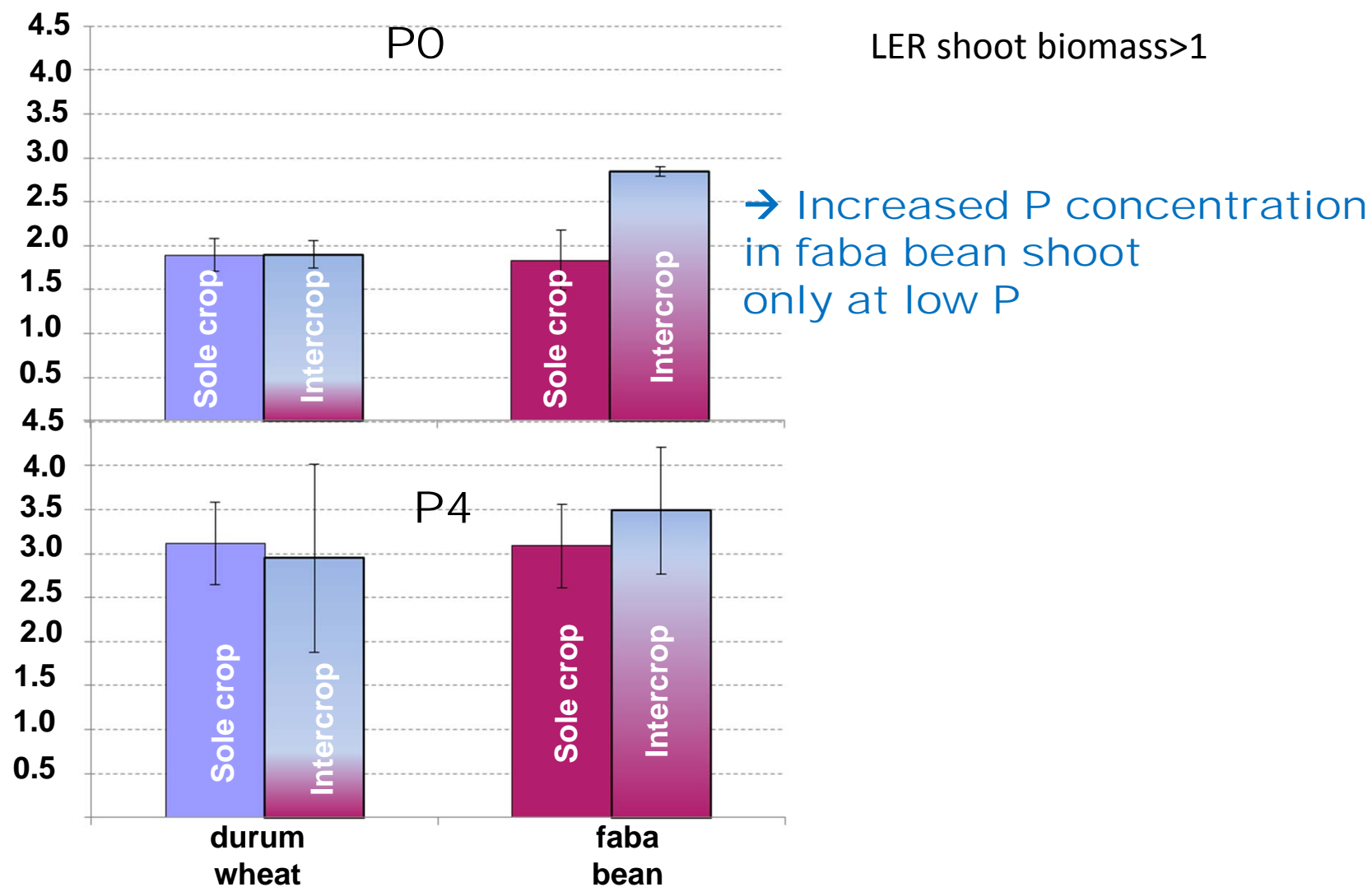
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P concentration
in shoot (mg.g^{-1})

Legume flowering stage



Context

- Crop productivity was enhanced in durum wheat-faba bean intercrop (**LER>1**) **compare to sole crop** when P availability was not limiting for growth → **stress gradient not verified at harvest**

Objective & Strategy

Plant-plant interactions are dynamic during crop growth with positive interactions for P until faba bean flowering stage

Results & discussion

- At low P availability (**P0**) interspecific belowground positive interaction **should** enhanced P acquisition **for faba bean intercropped with durum wheat until flowering stage of faba bean...**
... **but they were** not sufficient to suppress limiting effect of low P availability **on crop growth until harvest especially for the legume**

Conclusion

→ acknowledgements : funding body...



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Thank you for your attention