18th NITROGEN WORKSHOP

THE NITROGEN CHALLENGE: BUILDING A BLUEPRINT FOR NITROGEN USE EFFICIENCY AND FOOD SECURITY

18th Nitrogen Workshop

PROCEEDINGS

Lisbon, Portugal, 30th June – 3rd July 2014

Editor: Cláudia M. d. S. Cordovil

INSTITUTO SUPERIOR D AGRONOMIA
Universidade de Lisboa
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Sponsors:

The 18th Nitrogen Workshop was organized by the Instituto Superior de Agronomia of the Universidade de Lisboa, and supported by Central de Cervejas, Delta cafés, Unicer and Pastéis de Belém

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Proceedings of the 18th Nitrogen Workshop

Edited by: Cláudia S. C. Marques dos Santos Cordovil

Lisboa, Portugal, 30th June – 3rd July 2014

ISA Press

Printed by: Colibri Artes Gráficas

Edited by: Cláudia S.C. Marques dos Santos Cordovil

Design and composition:

Gonçalo Cordovil

Cláudia S.C. Marques dos Santos Cordovil

ISBN: 978-972-8669-56-0

Depósito legal n.º 377 322/14

Edição: ISA*Press*

Suggested citation: Author(s), 2014. Title. In: Cordovil C. M. d. S. (Ed.). Proceedings of the 18th Nitrogen Workshop – The nitrogen challenge: building a blueprint for nitrogen use efficiency and food security. 30th June – 3rd July 2014, Lisboa, Portugal, pp. nn-nn.

NITROGEN WORKSHOP – A leading network on Nitrogen

On the behalf of the organizing Commission of the 18th Nitrogen Workshop, I wish to express a warm welcome to all the participants.

This book contains the proceedings of the 18th Nitrogen Workshop, held in Lisboa, Portugal, from 30th June to 3rd July 2014.

The Nitrogen Worlshop is a leading network on all issues related to Nitrogen, since 1982. From an European network, the Nitrogen workshop grew to an international network, integrating more and more countries and enlarging its focus to broader questions about Nitrogen.

There was a global participation of scientists and technicians, from 30 different countries from all the continents, who presented the results of their collaborative work. This is a clear sign of the importance of these workshops and stressed out the leading position of this network in the field of the challenging Nitrogen element. The doors are open to the growth of the network.

We are proud to present an outstanding scientific program with high quality speakers and innovative posters presented by more than 200 delegates, which will hopefully give rise to interesting and participated discussions. We have put our efforts in the selection of an innovative and comprehensive overview of the latest research developments to share with you and we hope you enjoy the workshop. More that 200 posters were displayed in large poster sessions, to allow the participants the exchange of ideas and information amongst them. It is worth highlighting a strong participation of students which ensure and keep alive the research in the subject of Nitrogen.

We hope that this Workshop will host great opportunities for the participants to meet and build future collaboration through friendship and professional interaction, and that this may be place and time for discussing the latest developments in science and politics for Nitrogen issues, and a means of moving forward to problem solving, innovation and knowledge transfer.

We wish to express sincere thanks to all the persons that made the 18th Nitrogen Worshop possible. To the colleagues who kindly accepted to revise the abstracts submitted to this Workshop, to the Chair of the 17th Nitrogen Workshop for his advice, availability and support at all times, to the Steering Committee of the International Nitrogen Initiative (INI) for scientific advice and to the European Centre of the INI for supporting this meeting.

Cláudia S. C. Marques dos Santos Cordovil

History of the Nitrogen Workshop

"The nitrogen challenge: building a blueprint for food and future"

- 17th International Nitrogen Workshop: Wexford, Ireland. **"**Innovations for sustainable use of N resources".
- 16th International Nitrogen Workshop: Universita Degli Studi di Torino, Italy. 28 June - 1 July 2009. "Connecting different scales of nitrogen use in agriculture
- 15th International Nitrogen Workshop: University of Lleida, Spain. 28-30 May 2007. "Towards a better efficiency in N use"
- 14th International Nitrogen Workshop: PRI, Maastricht, The Netherlands. 24-26 October 2005. "N Management in Agrosystems in Relation to the Water Framework Directive".
- 12thInternational Nitrogen Workshop: IGER, University of Exeter, UK.

  21-24 September 2003. "Controlling nitrogen flows and losses".
- 11th International Nitrogen Workshop: INRA, Reims, France. 9-12 September 2001
- 10th International Nitrogen Workshop: The Royal Veterinary & Agricultural Univ Copenhagen, Denmark. 23-26 August 1999
- 9th International Nitrogen Workshop: Technische Universitat Braunschweig, Germany. 9-12 September 1996
- 8th International Nitrogen Workshop: University of Ghent, Belgium. 5-8 September 1994.
- 7th International Nitrogen Workshop: University of Edinburgh, UK. 3-26 June 1992
- 6th International Nitrogen Workshop: The Queen's University Belfast, UK. 17-19 December 1990
- 5th International Nitrogen Workshop: Rothamsted Experimental Station, UK. 13-14 December 1988
- 4th International Nitrogen Workshop: University of Aberdeen, UK. 6-9 April 1987
- 3rd International Nitrogen Workshop: GRI, University of Reading, UK.

  16-17 December 1985
- 2nd International Nitrogen Workshop: Rothamsted Experimental Station, UK. 17 July 1984
- 1st International Nitrogen Workshop: Rothamsted Experimental Station, UK. 20 July 1982

18th Nitrogen Workshop

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INTERCROPPING LEGUME AND NON-LEGUME, AN INNOVATIVE WAY TO VALORIZE N2 FIXATION AND SOIL MINERAL N SOURCES IN LOW INPUTS CROPPING SYSTEMS.

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Increasing concern about climate change and environmental impacts require transformation of actual cropping systems focusing on enhanced sustainability. Then, optimizing the use of natural N sources such as N2 fixation and soil mineral-N coming from organic matter mineralization is crucial. One solution could consist in increasing the diversification of crops across the European countries e.g. by implementing more legumes crops or by developping the use of intercropping (IC) such as cereal and legume mixtures. IC is the simultaneous growth of two or more species in the same field for a significant period and an application of ecological principles. IC is known to use available abiotic resources more efficiently than the corresponding sole crops particularly in low-input systems. Indeed, well chosen intercropped species do not compete for exactly the same resource niche but tend to use them in a complementary way leading to higher yield and grain protein compared to sole crops (e.g. Hauggaard-Nielsen et al. 2007; Bedoussac and Justes 2010). The main objective of our field studies was to analyse the functioning of cereal – grain legume intercrops as a first step to further optimize and finally propose optimised intercropped systems. Thus, we evaluated the potential advantage of intercrops for global yield and wheat grain protein concentration modified by N-fertilization, densities, species and cultivars.

Materials and Methods

58 organic field experiments were carried in France (Toulouse in the SW France and Angers in the NW) and Denmark from 2001 to 2010 with a large range of intercrops combinations (hard wheat, soft wheat or barley intercropped with pea or faba bean) with various cultivars, sowing densities and N treatments leading to a large range magnitude and dynamics of N availability. Grain yield was used to calculate the efficiency of IC based on the land equivalent ratio (LER) i.e. the relative land area under SC that is required to produce the yield achieved in IC. Cereal grain protein content was also analysed as a quality criteria and the percentage of N derived from N_2 fixation (%Ndfa) of legumes was evaluated in order to estimate all N sources.

Results and discussion

Total intercrop grain yield (cereal + legume) was almost higher than that of the mean SC grain yield (3,3 vs. 2,7 Mg ha-1 respectively; Figure 1) and the proportion of cereal yield in IC was higher than 50% and higher to that calculated from SC grain yields, indicating an higher competitivity of the cereal. LER values are almost higher than 1 (1,27 on average ranging from 0,93 to 2,41). High values (>1,5) correspond in general

to situations in which at least one of the sole crop grain yield was low. IC was more efficient than SC without N fertilization or when N was applied late during cycle; this is mainly due to: i) a better light use (up to 10%) thanks to species dynamic complementarity for leaf area index and height, ii) growth complementarity over time (higher growth rate of the cereal and then of the legume), and iii) a dynamic complementary in N acquisition, i.e. N_2 fixation and soil mineral N. Disadvantages were observed with large available-N during early growth stages leading to higher cereal growth, increasing interspecies competition, reducing legume light absorption and then its biomass and yield. Cereal grain protein concentration was significantly higher in IC than in SC (11,1% vs. 9,8%; Figure 2) and the lower the SC grain protein concentration the higher the increase of N concentration in IC. The grain protein concentration increase in IC is due to: i) a lower cereal grain yield in IC than in SC (1,9 vs. 2,9 Mg ha-1 respectively) due to lower sown density density and so on fewer ears per square meter in IC and ii) a quite similar (ca. 90%) amount of available soil N for the cereal in IC compared to SC because of a high legume N_2 fixation rate in IC (75%) leading to a small amount of soil mineral-N uptake by the legume. The percentage of N derived from N_2 fixation of legumes was significantly higher in IC than in SC (75% vs. 62%) but the amount of N fixed was lower in IC (56 vs. 93 kg N.ha-1) due to a smaller biomass than in SC.

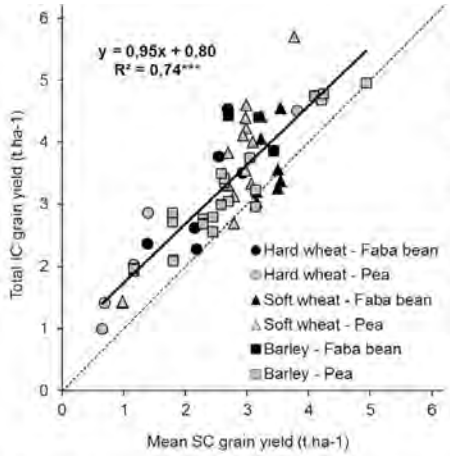

Figure 1: Comparison of the intercrop (IC) grain yield (cereal + legume) with the mean sole crop (SC) grain yield.

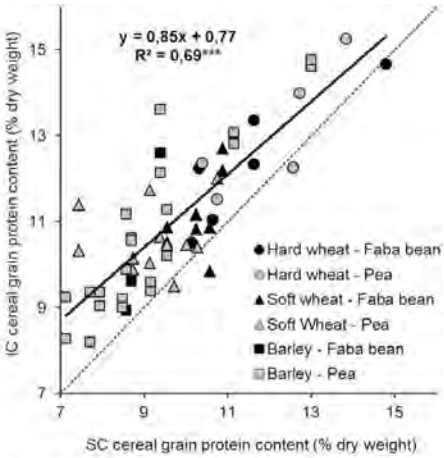

Figure 2: Comparison of the intercropped (IC) cereal grain protein concentration with that of the sole cropped (SC) cereal.

Conclusions

Our work confirms that IC is particularly suited to low N input systems due to the complementary use of N sources by species allowing a better wheat grain filling. However, a number of factors still need to be optimized in order to propose future cropping systems appropriately optimized, such as grain legume cultivars, sowing practices and design depending on specific goals (e.g the maximum total yield, global protein production, highest wheat grain protein content or multicriteria objectives).

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Hauggaard-Nielsen H., Jørnsgaard B., Kinane J., Jensen E. S. 2007. Ren. Agric. Food Syst., 23:3-12.
Naudin C., et al. 2009. J.Agric. Sci.Technol., 3:17-28.