



# Fostering Populations Of Arbuscular Mycorrhizal Fungi Through Cover Crop Choices and Soil Management George Crane

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## Ancient Arbuscular Mycorrhizal (AM) Fungi



## **AM Fungi 450 Million Years Later**

- Interact with **80%** of extant land plants
- Essential for ecosystem functioning

- Studies show that colonisation by AMF resulted in:
  - 35% increase in **biomass**
  - 23% increase in yield

..But intensive agriculture detrimental to AM fungi



Image: Mieke Jürgens

(Van Geel et al. 2016, Lekberg and Koide 2005)

## (Some) Farming Practices are Detrimental to (Some) AM Fungi



- Agriculture selects for generalists which are tolerant to disturbance
- R-selection favours organisms adapted to environments requiring fast, copious reproduction and dispersal.
- These species may not provide the same benefit to crops
  - Glomus sp. Dominate in agriculture

(Verbruggen and Kiers 2010)

- The use of cover crops promote the establishment, and maintenance of a diverse range of AMF species, which facilitates increased interaction with following cash crops
- 2. Increasing **diversity** and **abundance** of arbuscular mycorrhizal fungi improves **soil health**, crop growth, and yield of following cash crops

#### **Cover Crops Can Improve Colonisation and Diversity of AM Fungi**



#### **Increasing AM Diversity To Increase Benefit**



## **Current Projects – UK Wide Assessment of AM Fungal Diversity**



## **FERA Big Soil Community**

- UK wide assessment of agricultural soil microbiome
- 258 soil samples submitted
- Sequenced for fungal ITS and bacterial 16S
- No AM fungi detected
- 150 of 258 sites selected
- 18S rDNA for AM fungi
- Nextera barcoded NS31-AML2



## 83 AM Virtual Taxa (VT) Identified in UK Samples



#### Most common OTUs

- VTX00281 Paraglomus laccatum
- VTX00283 Ambispora fennica
- VTX00448 Glomus SS-G1
- VTX00349 Paraglomus sp
- VTX00008 Archaeospora s. arch1
- VTX00065 Glomus caledonium
- 46% *Glomus* sp.

## **Current Projects – Replicated Field Trials**



## New Farming Systems (NFS) Fertility Building Rotations



- Legume mix, radish and black oat, fallow
- 0%, 50%, 100% nitrogen rate



## **Cover Crops Increase Colonisation of Spring Barley**



#### Treatment

Fallow
 Radish and Oat
 Legume Mix



## **Cover Crops Impact Yield of Spring Barley**



## **Current Projects – Replicated Field Trials**



## **Bawburgh Inoculation Trial**

|      | Rep 1 |    |    |    |    |    |    |    |    | Rep 2 |    |    |    |    |    |    |    |    | Rep 3 |    |    |    |    |    |    |    |    |
|------|-------|----|----|----|----|----|----|----|----|-------|----|----|----|----|----|----|----|----|-------|----|----|----|----|----|----|----|----|
| Trt  | 2     | 13 | 16 | 15 | 14 | 12 | 6  | 11 | 5  | 6     | 1  | 12 | 14 | 4  | 17 | 5  | 8  | 11 | 16    | 18 | 14 | 11 | 15 | 3  | 1  | 12 | 10 |
| Plot | 10    | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 28    | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 46    | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 |
| Trt  | 9     | 1  | 18 | 10 | 4  | 3  | 7  | 17 | 8  | 16    | 15 | 10 | 3  | 13 | 9  | 2  | 7  | 18 | 9     | 6  | 17 | 13 | 8  | 7  | 4  | 5  | 2  |
| Plot | 1     | 2  | 3  | 4  | 5  | 6  | 7  | 8  | 9  | 19    | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 37    | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 |

Trt 

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#### Cover crop ± AM Inoculum



| Description                                                   |
|---------------------------------------------------------------|
| Untreated                                                     |
| Untreated+AMF                                                 |
| Smart Radish (10kg/ha)                                        |
| Smart Radish (10kg/ha)+AMF                                    |
| Vetch (100kg/ha)                                              |
| Vetch (100kg/ha)+AMF                                          |
| Oats (60kg/ha)                                                |
| Oats (60kg/ha)+AMF                                            |
| Smart Radish (6kg/ha) + Oats (30kg/ha)                        |
| Smart Radish (6kg/ha) + Oats (30kg/ha)+AMF                    |
| Smart Radish (10kg/ha) + Oats (30kg/ha)                       |
| Smart Radish (10kg/ha) + Oats (30kg/ha)+AMF                   |
| Oats (30kg/ha) + Vetch (50kg/ha)                              |
| Oats (30kg/ha) + Vetch (50kg/ha)+AMF                          |
| Smart Radish (10kg/ha) + Vetch (50kg/ha)                      |
| Smart Radish (10kg/ha) + Vetch (50kg/ha)+AMF                  |
| Smart Radish (10kg/ha) + Vetch (50kg/ha) + Oats (30kg/ha)     |
| Smart Radish (10kg/ha) + Vetch (50kg/ha) + Oats (30kg/ha)+AMF |
|                                                               |

#### AM Inoculum (Almost) Reduces Yield of Spring Barley



# **Current Projects – Farm Scale Trials**



## **Innovative Farmers (IF) Experiment**

- Use of farm produced anaerobic digestate
  (AD) as a soil amendment
- Using cover crops to stabilise soil N, reduce
  nitrification and leaching
- Economic and environmental goals
- Subset of 4 of the original 7 IF sites



## **IF Experimental Design**

- 2 hectare split field plots
- Radish, oat, vetch, (and buckwheat) cover crop
- Maize cash crop
- Farm practice and machinery



#### **Cover Crops Reduce Leaching to Lower Soil Horizons**



#### Maize Biomass Is Not Influenced by Cover Crops or AD



#### **Thanks!**



- Dr Lydia Smith and the Innovation Farm team
- Professor Uta Paszkowski and the Cereal Symbiosis lab.
- Dr Nathan Morris, Dr Liz Stockdale, David Clarke, and the trials team at NIAB Morley
- Innovative Farmers: Jim and Patrick Allpress, Andrew Blenkiron, James Beamish, Phil Rayns, Robert England, and David Wright











