

Newly discovered micro-organisms that will change the face of agriculture

Brian R. Murphy
Department of Botany
School of Natural Science
Trinity College Dublin
murphb16@tcd.ie

Fiona M. Doohan, UCD
Trevor R. Hodkinson, TCD



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A story of discovery

2/18/2015 Fungus May Save Crops from Disease and Global Warming - Scientific American

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Fungus May Save Crops from Disease and Global Warming

Endophytes that live in plant cells could confer a host of benefits

ClimateWire

February 17, 2015 | By Niina Heikkinen and ClimateWire

As scientists seek to make crops resilient against disease and the effects of climate change, they are turning to what may seem like an unlikely champion: fungi.

Specifically, they are studying endophytes, a type of fungus (or bacteria) that lives inside plant tissue and has no apparent negative effects on its hosts. Endophytes do, however, provide important protections to plants, which is why researchers are focusing on how the organisms could be used commercially to improve food security.



Although endophytes live within tissues and are ubiquitous in the plant world, it wasn't until relatively recently that scientists even knew of their existence.
Credit: Wikipedia

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Barley, *Hordeum vulgare* L.

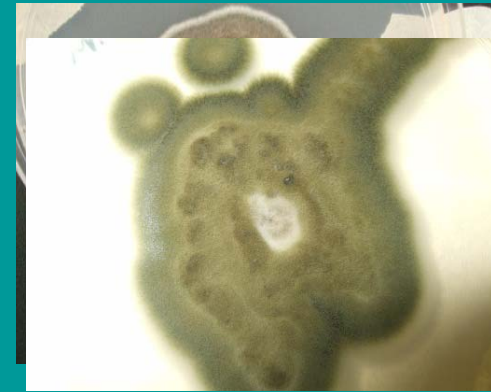


Harsh conditions but healthy plants



Hordeum murinum subsp. *murinum* L., 'wall barley'

Hyper-diversity in endophytes recovered from wild Irish relatives of barley



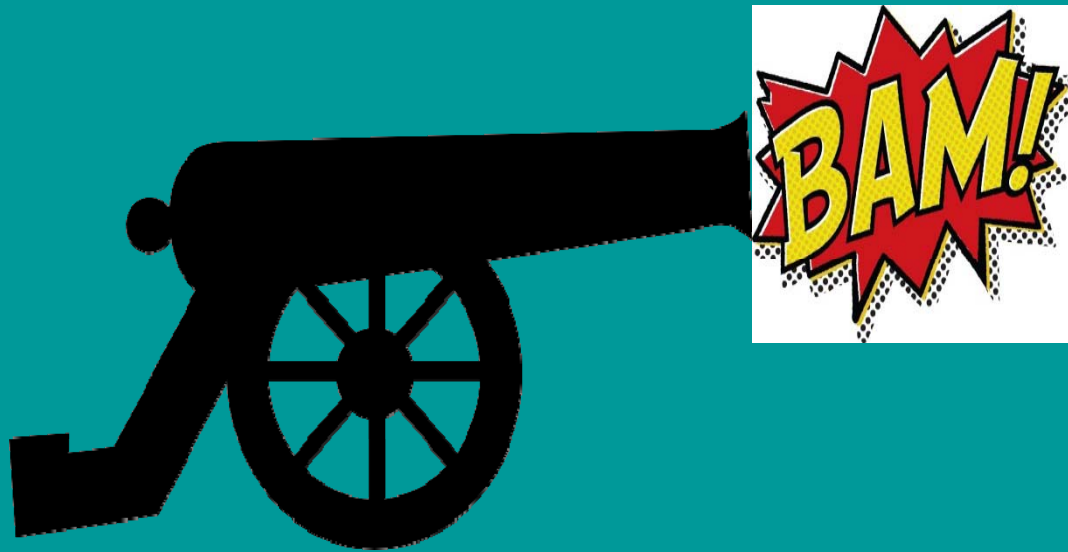
Suppression of seed-borne infections by co-inoculant of 10 endophytes



Lane 1 -3: endophyte-inoculated, lane 4 – 5 with just seeds

Identifying the active endophytes

Direct antagonism without the induction of systemic acquired resistance (SAR)



- *Fusarium*
- *Rhynchosporium*
- *Colletotrichum*
- *Cochioloobus*
- *Pyrenophora*

www.clker.com, www.jacketflap.com

Increase in grain yield in nitrogen-starved barley

+ 29%



- Endophyte



+ Endophyte

www.photo-dictionary.com

Increase in dry shoot weight

+ 70%



- Endophyte



+ Endophyte

Drought-stressed barley

< 15% soil moisture

Endophytes induced:

- Increase in tillering
- Increase in biomass
- Increase in yield
- Reduction of disease
- Reduced root allocation



Multiply-stressed barley

Heat 33° C
Drought <10%
Nutrient <20%
Pathogen Ggt



Endophytes induced significantly greater survival, $P < 0.01$

The difference between life and death?



+ Endophyte
>80% survival



-- Endophyte
13% survival

Can we place a value on these results?

For barley alone

Total spend on chemical crop inputs – Ireland

215,000 Ha

€104,000,000

Reduction of 25%

Total savings on chemical crop inputs – Ireland

€26,000,000

Can we place a value on these results?

For barley alone

Total spend on chemical crop inputs – World

56,000,000 Ha

€27,000,000,000

Reduction of 25%

Total savings on chemical crop inputs – World

€6,800,000,000

Can we place a value on these results?
Environmental costs, Biodiversity loss



Benign = heavy ineffective endophytes



Endophytes work best in conditions most similar to the site of origin

Implications for 'Principal Mode of Action'

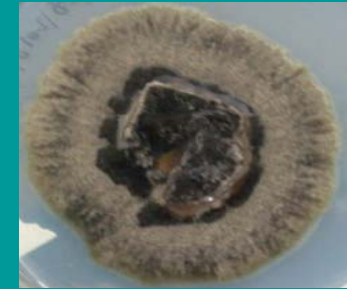
Unstable and environmentally dependent

Additive effects and synergy

Conditions	Endophyte 1	Endophyte 2	Endophyte 3	Combined
Low nutrients	++	--	00	++
Drought	--	00	++	++
Pathogen	++	++	00	++
Temperature	00	++	--	++
Multiple	00	00	00	++

Patents, papers and partners

- European patent
- Eleven papers
- Collaboration trials
- Commercialisation potential
- And newsworthy!



The future – increases in population, fertilisers and crop stress

Nutrient stress - 29% increase in grain yield

Heat stress - 6-fold plant survival

Drought stress – 94% increase in yield

Pathogen stress - 100% suppression

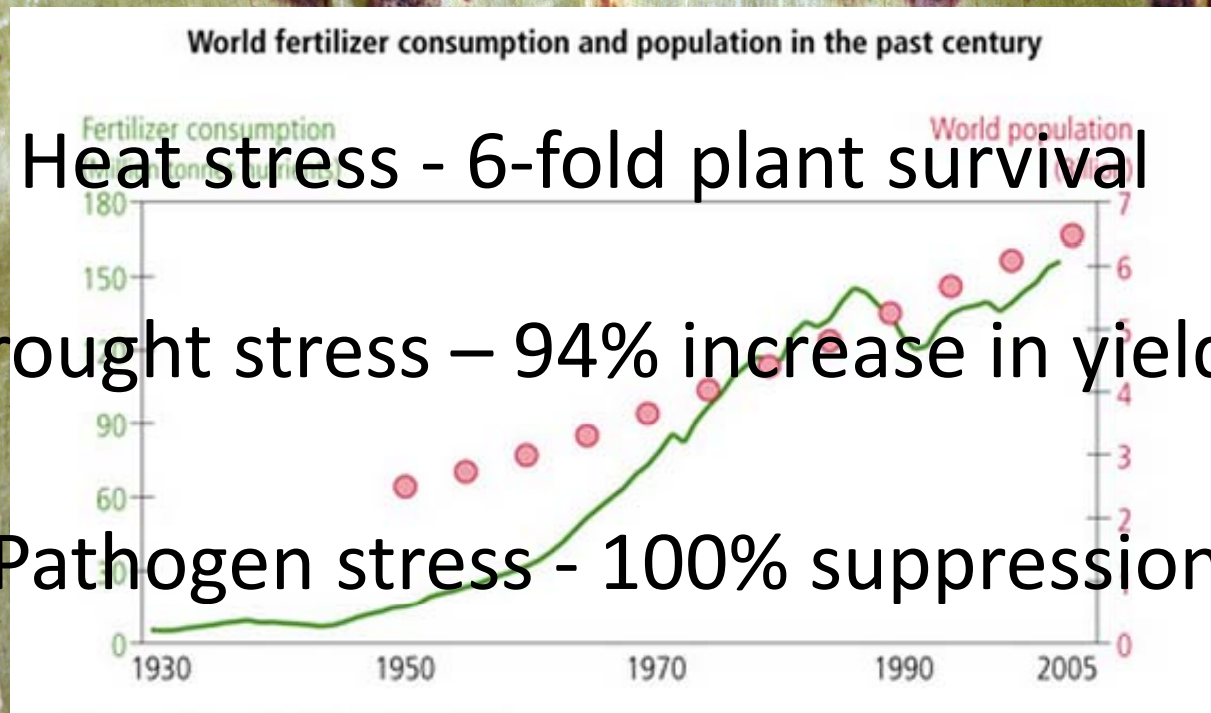
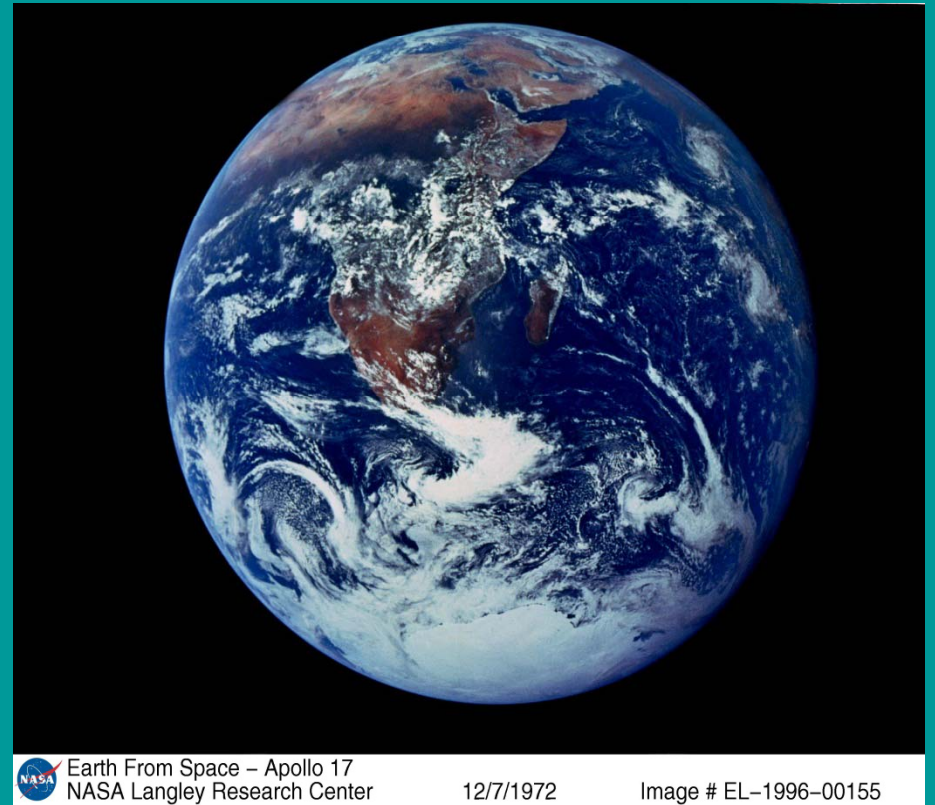


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Expanding the scope to feed the world

- Potential to develop the same technology for other crops
- Use similar techniques to identify beneficial endophytes
- ‘Personalised’ genotype and phenotype based application
- 22% more food required by 2050



Great potential for other cereal crops?

Cereals

Maize

173,000,000 Ha



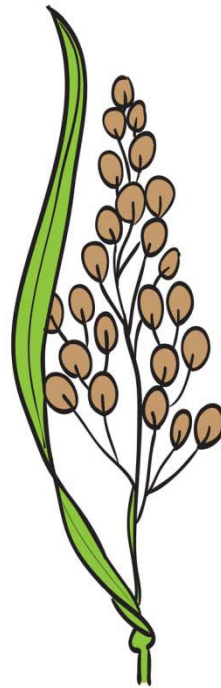
Wheat



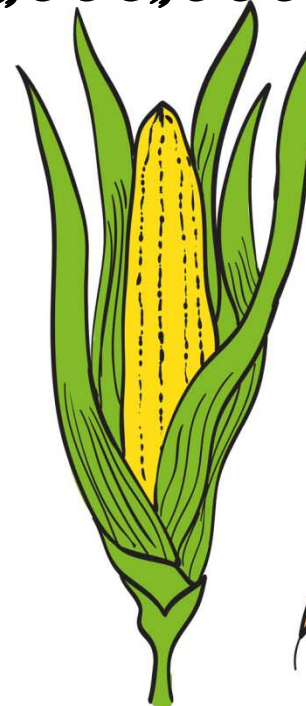
Barley



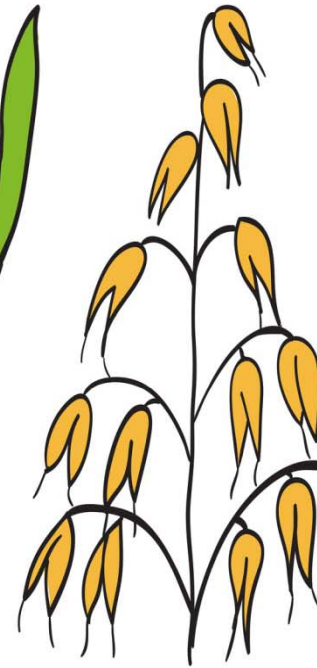
Rye



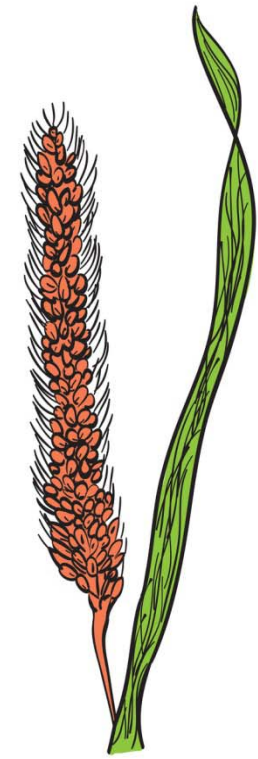
Rice



Maize



Oats



Millet

A European Initiative

- EU funded Action FA1103, Cooperation in Science and Technology (COST)
- The aim of the Action is to identify bottlenecks in the use of endophytes in biotechnology and agriculture and to provide solutions for the economically and ecologically compatible exploitation of endophytes.



The end of one story The beginning of another? Newly discovered micro-organisms will change the face of agriculture ?

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