ENDOSYMBIOSIS FOR ENVIRONMENTALLY FRIENDLY FARMING

John Innes Centre

Unlocking Nature's Diversity

THE CHALLENGE

Nitrogen and phosphate are essential nutrients for plant growth and they are applied as inorganic fertiliser to crops to enhance their yield. However, excessive fertiliser use may harm the environment.

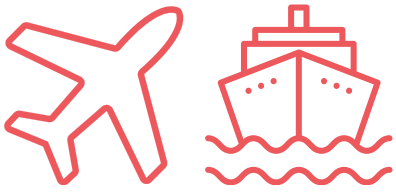
WHAT IS ENDOSYMBIOSIS?

Endosymbiosis is where two organisms are in a mutually beneficial association with one another. Plants can form mutually beneficial associations with certain soil microbes which provide the plant with nutrients in return for carbohydrates from the plant.

We could reduce the use of inorganic fertilisers by enhancing nutrient uptake through improvements in mutually beneficial relationships between plant roots and soil microbes.

50%

OF APPLIED INORGANIC FERTILISER IS LOST TO THE ENVIRONMENT



FERTILISERS EMIT MORE CARBON PER YEAR THAN GLOBAL AVIATION AND SHIPPING COMBINED

OUR RESEARCH

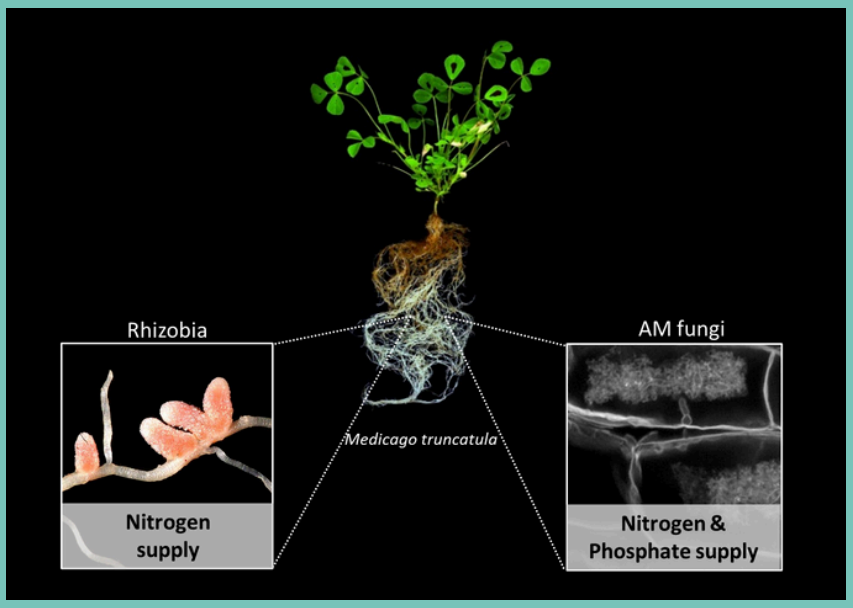


Image: nitrogen fixing rhizobia in root nodules and arbuscular mycorrhizal (AM) fungi in root cells of the model legume *Medicago truncatula* (credit: Myriam Charpentier).

Mutually beneficial associations between plant roots and soil microbes, such as nitrogen-fixing rhizobia or arbuscular mycorrhizal fungi, enhance nutrient uptake and reduce the amount of inorganic fertiliser needed.

Although biological nitrogen fixation by rhizobia occurs only in the root nodules of legumes, it is thought that 80 per cent of land plants can benefit from associations with arbuscular mycorrhizal fungi.

Enhancing these associations will be key to making crops less dependent on inorganic fertilisers.

Research at the John Innes Centre has identified a mutation within a gene that enhances endosymbiosis. This mutation, originally identified in the model legume *Medicago truncatula*, was transferred into wheat, where it similarly enhances the association with arbuscular mycorrhizal fungi.

Arbuscular mycorrhiza and, importantly, nutrient acquisition from the soil was increased in wheat plants grown in growth chambers and in field conditions. In field trials, wheat plants carrying the gene mutation enhanced endosymbiosis with arbuscular mycorrhizal fungi by 20 per cent and showed a 10 per cent increase in leaf nitrogen to carbon ratio, an indicator of increased nutrient acquisition.

Field trials in collaboration with plant breeders are now underway to determine whether wheat yields that are achieved with a standard fertiliser application level can be matched with the wheat lines we have generated, with enhanced endosymbiosis and with less fertiliser. Furthermore, the mutation had a conserved effect between the distantly related legume and wheat, it is therefore possible that this mutation could provide enhanced endosymbiosis in other crop plants. This new knowledge provides the potential for sustainable crop production using endosymbionts alongside reduced fertiliser use.

SCAN FOR MORE INFO

UKRI Biotechnology and Biological Sciences Research Council

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