The discovery of a malfunctioning relationship between soil bacteria and clover sheds new light on a process that underpins agriculture around the world.

Dr Michael Djordjevic from the ANU Research School of Biological Sciences has published his findings on the symbiotic ‘stuff-up’ in the latest edition of *Molecular Plant Microbe Interactions*.

Legume plants, which include clovers, rely on soil bacteria to form tiny new organs called root nodules. Inside the nodule the bacteria convert atmospheric nitrogen to ammonia (a form of fertiliser). Unlike other plants, the legume’s entire requirement for nitrogen can be provided by the bacteria.

This symbiosis underpins agriculture worldwide. For example, efficient production of wheat in Australia is not possible without first growing legume pastures such as clover prior to growing wheat so that the nitrogen content in the soil is replenished.

But Dr Djordjevic found that certain clover bacteria failed to establish normal infections in the roots of a particular variety of clover called Woogenellup. This resulted in abnormal and stunted root nodule development.

“This is something like a false start in a 100-metre dash. The bacteria with stalled infections induced two other organ types with some similar features to nodules,” Dr Djordjevic said.

One of the abnormal growths, named a ‘hybrid’, had never been seen before. In these cases, the symbiosis failed to establish and the plant does not benefit from the association.

“This bacterial strain is still used by agricultural companies to inoculate other clover pastures to enhance soil fertility, but the failed symbiosis is a reason why Woogenellup has been replaced by other varieties,” Dr Djordjevic said.

The researchers are not sure what causes the malfunction.

“These abnormal infections may represent an intermediate step in the evolution of nodules where the bacteria make the right signal but the fine tuning of symbiosis is not optimal,” Dr Djordjevic said.

“Another possibility is that the bacteria make two competing signals: one triggering nodule formation and the other lateral roots and the plant becomes confused.”

Root nodule formation is a relatively young process: the oldest fossilised legume nodules date back 60 million years. Over millions of years of evolution, plant and bacterial cells have learnt to co-exist in a fine-tuned intimate association. Normally, plant infection by bacteria would result in disease.

ANU is a partner institution in the ARC Centre for Excellence for Integrative Legume Research.

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