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News

Bacteria get the upper hand on modern crops

New soya-bean breeds don't cope well with swindling bacteria.

Heidi Ledford (/news/author/Heidi+Ledford/index.html)

Decades of breeding high-yielding soya-beans in fertilized soils has produced varieties that have lost the ability to interact effectively with soil bacteria, researchers have found. The results suggest that modern breeds of soya beans, and possibly other crops, may now be less suited for growth in low-nutrient conditions, such as the unfertilized fields of developing countries.

Modern soy may find it harder to grow in unfertilized fields. *Punchstock*

"I would say it's worrying," says Ford Denison, a plant ecologist at the University of Minnesota in St Paul and a co-author on the study. "It's something that I would like plant breeders to recognize."

Soya beans do not typically require fertilizer because they live together with soil bacteria that 'fix' atmospheric nitrogen into more useful forms, such as ammonium, that can be used by the plant. In exchange, the plants provide carbon to the bacteria.

But fixing nitrogen is costly, and not all bacteria put much effort into the process. Soils contain some strains of bacterial 'swindlers', which live off plant roots without giving much nitrogen in return.

Previous research has shown that soya beans tend to fight back against such swindlers, providing less carbon to cheaters and extra carbon to the more generous bacteria. This encourages the growth of beneficial bacteria[1 (#B1)].

Modern agricultural practices, however, have partially relieved soya beans from having to fight this battle. Although the plants are not directly fertilized, residual fertilizer is often left in the soil after rotating other crops through the same field. And farmers sometimes inoculate soya bean seeds with strains of nitrogen-fixing bacteria that are particularly adept at fixing nitrogen.

Lost talent

Toby Kiers, now at VU University in Amsterdam, and her colleagues wondered whether these conditions might have affected the ability of soya beans to distinguish helpful bacteria from cheaters. The researchers gathered six soya bean variants from throughout 60 years of crop breeding history, and grew them in unfertilized fields. They tested the soya beans by providing them with mixtures of bacteria containing good nitrogen fixers and closely related bacteria that couldn't fix nitrogen at all.

Seed production in the more modern breeds of soya bean declined more than in older breeds when cheating bacteria were present, suggesting that older breeds are able to cope better with the presence of such cheaters, they found[2 (#B2)]. The results are published this week in the *Proceedings of the Royal Society Lond.*

"Modern plant breeding has allowed this trait to slip through the cracks."

Tim Crews

"The difference between old and new was enough to eliminate the yield benefit of all of these decades of breeding," says Denison. Plant breeders may not have detected the decline in performance, he notes, because fertilized soils and inoculation with robust nitrogen-fixers may have masked the trait. Alternatively, other benefits of the new breeds, such as disease resistance, may have outweighed the detriments of reduced bacterial selection in some regions, he adds.

Nevertheless, those bacterial relationships are important in non-fertilized soils, as is often found in developing nations. Soils also vary in the quality of their nitrogen-fixing bacteria, and some regions have a high proportion of 'cheaters'. Under these conditions, the ability of soya beans to direct their efforts to rewarding bacteria is probably more important.

Important partners

Breeders can now cross new, higher-yielding breeds with old varieties to try to recoup the ability to cope with cheating bacteria, notes Tim Crews, an ecologist at Prescott College in Arizona, who was not involved with the work.

The results provide a reminder that breeders should consider ecological relationships when they select their crops and breed for high performance, says Crews. "Modern plant breeding has allowed this trait to slip through the cracks," he says.

Previous research has suggested that interactions of some crops, including wheat, corn and soya beans, with certain soil fungi may also have become less beneficial over time. This could be a consequence of using fertilizers in breeding programmes, notes Denison.

“It raises the question in my mind: what else are we missing?” says Crews. “We could be doing a lot more with a lot less.”

References

1. Kiers, E. T., Rousseau, R. A., West, S. A. & Denison, R. F. *Nature* **425,** 78-81 (2003).
2. Kiers, E. T., Hutton, M. G. & Denison, R. F. *Proc. R. Soc. Lond. B.* doi: 10.1098/rspb.2007.1187 (2007).

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As a plant breeder i support these views but wonder if the same may be true also for other nutrients where under best management practices in trials, we may be too generous with N, P, K & Mg and therefore may be missing out on genotypes which are more efficient in the uptake of any of these nutrients. This has been seen for Mg for oil palms grown in Papua New Guinea (at DAMI Research). My own experience has shown some genotypes which are prone to Boron deficiency although this nutrient is required only in small doses (100-150 gms/palm/year) in mature palms. P and VAM association is reduced when higher rates of external P is applied but is the any interaction by the genotype. Would appreciate some comments on this.

Posted by: **Mukesh Sharma** | 19 Oct, 2007

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