Novel synthetic polymers could lead to greater crop yields for farmers

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Scientists at the University of Birmingham have invented a new method to encourage bacteria to form growth-promoting ecosystems that could be used to coat the roots of plant seedlings, which is expected to result in

stronger, healthier plants, and higher crop yields in agriculture.

In nature, the roots of seedlings form mutually beneficial relationships with communities of microbes (fungi, bacteria, viruses) in soil, and exchange nutrients, allowing both the plant and the microbes to flourish. This is particularly critical in the early stages of a plant's life when the seedling is in a race against time to reach self-sufficient growth before the nutrients and energy stores in the seed run out.

Dr. Tim Overton, an applied microbiologist from the University's School of Chemical Engineering, and Dr. Francisco Fernandez-Trillo from the School of Chemistry led a team to develop novel synthetic polymers that stimulate the formation of these bacterial communities in a way that mirrors a natural process known as biofilm formation.

A biofilm is a finely orchestrated community of microbes, supported by matrix of biological polymers that forms a protective micro-environment and holds the community together.

The researchers worked jointly on a four-year project on how polymers interact with bacteria, which resulted in the synthesis of a group of acylhydrazone-based polymers.

These new polymers were designed to act as an adhesive scaffold, "seeding" the formation of a microorganism-polymer complex to initiate and expedite biofilm formation. Once the biofilm is formed, the bacteria become a self-sufficient and self-organizing community, and produce their own matrix to allow the transmission of nutrients and water, and the discharge of waste products.

The project involved Ph.D. students Pavan Adoni and Omar Huneidi, who subsequently progressed research showing the polymers aggregate bacteria, and improve biofilm formation. Critically, they also showed the

process is fully reversible, and the biofilm can be dispersed by changing the environmental conditions. The results of these experiments and further studies will be published in 2022.

Pavan Adoni commented, "We anticipate that the polymer will ultimately be used as a seed coating, perhaps in conjunction with bacteria such as B. Subtilis, which is naturally present in soil, increases the stress tolerance of plants, and is currently used as a soil inoculant. We envisage a more targeted approach that only treats the seed, so that when it germinates the bacteria are ready to grow in the safe harbor environment provided by a microorganism polymer complex. Ultimately this should result in stronger plants, which grow more quickly, and have greater resilience to disease."

University of Birmingham Enterprise has filed a broad-based patent application covering the novel polymers, the method of forming the biofilm and the method of polymer cleaving, and its use to promote growth of a biofilm with any microorganism including those that can produce or deliver chemical or biological molecules.

The patent has now been licensed to specialist life science company PBL Technology, which invests in, protects and promotes emerging innovations from public research sources worldwide. In agriculture, PBL's technologies include crop genetics, crop treatments, precision agriculture and promoters and R&D tools.

Provided by University of Birmingham