REVOLUTIONARY CROP NUTRITION

# PROBIOTICS PROMOTE HEALTHIER PLANTS

These microbes are a renewable, clean alternative to chemical fertilisers, write **DR HOE-HAN GOH** and **DR HAMIDUN BUNAWAN**

*Half of the world's food supply depends on fertiliser, the fuel that powers modern agriculture, but with environmental impact.* FILE PIC

WHEN considering probiotics, we tend to think of the helpful live gut bacteria and yeasts that are good for our digestive system.

However, probiotics are just as useful in balancing the millions of good and bad microbes in plants and soils. When the bad germs overwhelm the good ones, you can get sick. The same applies to plants and soils.

Harmful microbes are parasites that infect and steal nutrients from the plants. On the contrary, beneficial microbes not only help plants to fight pathogens, they continually break down organic materials for plant absorption and growth. Some microbes can bind heavy metals, radionuclides, and organic toxins, thus protecting the plants.

Furthermore, microbes also contribute to soil aggregation by binding together soil mineral particles and organisms to each other through a glue-like secretion called glomalin by the arbuscular mycorrhizal (AM) fungi. This physically stabilises the soil in reducing runoff, improves water retention, and increases oxygen content in the soil. These processes happen naturally in healthy, productive soils as promoted by organic farming.

On the other hand, chemical farming or industrial agriculture is highly dependent on synthetic nitrogen fertilisers in feeding the plants, not the soil, or the microbes that need organic materials. Nitrogen is essential as a building block of life: DNA and proteins. Plants rely on microbes to convert unusable nitrogen abundant in the atmosphere into ammonia and nitrate that plants can uptake for growth.

Legumes such as peas, soyabeans, and peanuts form nodules containing living nitrogen-fixing bacteria in their roots. It is nature's way of nurturing crops. However, the majority of cereal crops like maize, rice, and wheat do not have such microbial symbionts.

Half of our world's food supply depends on fertiliser — the fuel that powers modern agriculture in the past century with consequential environmental impact. Not only does industrial fertiliser production cost over three per cent of the world's energy, its decomposition into nitrous oxide — a greenhouse gas (GHG) is 300 times more potent than carbon dioxide (CO2) and is responsible for five per cent of global warming. Fertiliser also drives up the salt index in the soil and changes the pH. Runoffs of excess fertilisers into rivers result in eutrophication with algal blooms suffocating aquatic life. This has contributed to more than 500 dead zones of hypoxic areas so toxic that nothing lives.

To combat the environmental impact of synthetic fertilisers, Pivot Bio, a US company funded by US$70 million (RM291.06 million) from Bill Gates, and backed by Breakthrough Energy Ventures, is launching a revolutionary crop nutrition approach that could disrupt the US$200 billion fertiliser market.

The company is devising a renewable, clean alternative to chemical fertilisers by enabling nitrogen-producing microbes (probiotics) as a crop nutrition tool for maize farmers.

Plant probiotics refer to the endophytes, microbes that live between plant cells. Plant endophytes serve similar functions for plants as probiotics do for us in boosting resistance to disease. Some endophytes like the nitrogen-fixing bacteria help the plants to absorb nitrogen from the air.

Based on the concept that plants rely on helpful bacteria and fungi to survive and thrive, endophytes from one plant species could provide other species huge enhancements in strength and growth. Under the same conditions, probiotics promote healthier plants through a steady supply of long-lasting nutrients through a symbiotic relationship.

Probiotics adhere to the roots and feed the crop daily with no leaching. By building up natural resistance in plants, usage of fertiliser and pesticides can be reduced or eliminated. Less agrichemicals means less contamination of our local water supply or surrounding ecosystem, and lower agricultural carbon footprint.

Some endophytes stimulate the plant to produce hormones such as auxin that promote root growth to become deeper and fuller for more efficient uptake of soil water and nutrients. These plant-growth-promoting bacteria include Bacillus, Paraburkholderia, Pseudomonas, Acinetobacter, Alcaligenes, Arthrobacter, and Serratia. Additionally, these probiotics also provide beneficial effects through the production of antibiotics and lytic enzymes, solubilisation of soil mineral nutrients, and induction of systemic resistance in the host plants.

One of the reasons why probiotics naturally help promote resilient plants is they are extremely adaptive. Compared to plants with limited genetic adaptability to environmental changes such as drought or heat, probiotics can rapidly evolve under adverse conditions due to their short lifespan. Plants are healthier for having the right microbes for the conditions, akin to us taking probiotics to improve health.

Reducing the use of agrichemicals is important for food crops due to both environmental and health hazards, especially vegetables and fruit crops for fresh consumption. A recent study supports root-dwelling rhizobacteria probiotics as an environment-friendly supplement for strawberry cultivation. Not only did the yield increase by up to 48 per cent, various antioxidant (carotenoids, flavonoids, phenolics, and anthocyanins) contents and total antioxidant activities of strawberry fruits also increased.

Early supply of probiotics precludes root colonisation by pathogenic bacteria, which could also enhance resistance to diseases such as black root rot. Adopting fortified biofertiliser with probiotics seems to be the perfect way to reduce the global impact of fertiliser pollution as well as promoting soil health.

Hence, more agri-biotechnological research should be encouraged into future development of probiotics that can solubilise phosphorus and potassium for staple crops because invasive mining has nearly stripped the world's phosphate reserves.

Incentives can be provided for the biofertiliser industry or farmers practising a sustainable farming approach through reduced use of chemical fertilisers. This not only helps reduce our carbon footprint, but also enables the naturally-occurring microbes to thrive with plants as nature intended.

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