DARK SEPTATE ENDOPHYTE:

A NOVEL SOLUTION FOR SOIL DEGRADATION AND CLIMATE CHANGE

Amid the accelerating decline of arable land and degradation of agricultural soil around the world, a new technology has emerged from Ibaraki University in Japan that is expected to optimize plant growth in all environments, even extreme ones. By utilizing the power of a natural microorganism that colonizes the roots of plants, it has opened up new possibilities in a wide range of fields, from agriculture to reforestation and urban greening.

Over the years, climate change, excessive pesticide use, and other factors have spurred the loss of the world's farmland. It is estimated that over 90% of the world's soil could be degraded by 2050. Amid advanced ameliorative efforts underway in various countries, in Japan, a new technology harnessing the powers of a microorganism known as dark septate endophyte (DSE) has recently garnered attention.

Endophytes are microorganisms that live in a symbiotic relationship within their host plants. While present in almost all plants, some are able to enhance plant immunity and growth. Recent years have witnessed the appearance of technologies applying these powerful microbes to diverse areas, including agriculture and reforestation.

Organic strawberries treated with DSE, grown during the summer in a warm region of Japan, in an environment without air regulation or other control systems.

DSE is an endophyte that colonizes the roots of plants. Through nearly three decades of research on DSE, Professor NARISAWA Kazuhiko of Ibaraki University's College of Agriculture has learned that superior strains of the organism have a broader range of effects than other microbes currently in commercial usage. Besides enabling plant growth in such harsh habitats as acidic, dry, or highly saline soil, DSE can facilitate flowering and fruiting regardless of climate or sunlight duration. Additionally, by connecting with external fungi through their hyphae, DSE can be expected to have even greater effect on promoting plant growth. "This technology can be applied to a broad range of fields, from agriculture to reforestation, urban greening, and the cleanup of contaminated soil," said KAZAOKA Toshiki, CEO of endophyte Inc., a startup he cofounded with Narisawa in 2023 for the social application of DSE technology.

KAZAOKA Toshiki, CEO of endophyte Inc. (left), and KASAHARA Chiaki, in charge of overseas operations (right).

Not only does DSE boast the potential to form symbiotic associations with a wide variety of plants, it also offers the benefit of being easy to cultivate, which can reduce mass production costs. Each strain of DSE affects plants differently, but as endophyte Inc. possesses over 10,000 strains—one of the world's leading collections—gathered by Narisawa from nutrient-poor forest soil, the company can select those optimal for the purpose.

The use of DSE would also enable the realization of a high level of quality and the overcoming of other issues that would be difficult even in normal environments.

Although sugar beets—the raw material for sugar—are normally grown in cool climates, during a control experiment conducted in a warm region of Japan, nearly 40% of untreated plants (left) wilted; in contrast, those treated with DSE (center and right) achieved an average sugar content and yield comparable to those grown in colder regions.

Right: DSE (pictured) lives symbiotically with the roots of plants, extending hyphae into the surrounding soil to promote the absorption of water and nutrients that are conventionally difficult to absorb, while also enhancing plants' resistance to environmental stress.

The key lies in its synergy with stress—for example, tomato plants grown with a limited supply of water tend to grow firmer and tastier fruit, but would likely die if under too much stress. That is where the microorganism comes into play. Incorporating DSE could potentially allow plants to withstand high levels of stress, while lending them the potential to develop into higher quality crops.

A case in point is an experiment the company conducted on strawberries, which normally do not grow well in high-temperature environments and are understood to require sophisticated techniques and experience to cultivate. Though the experiment was conducted in a warm region of Japan in the summer, where inexperienced growers cultivated organic strawberries in an environment without air regulation or other controls, the strawberries treated with DSE not only grew without issues, but also produced fruit with a high sugar content of 19–20 degrees compared to the usual 10–12 degrees for summer strawberries. Kazaoka said, "Our ultimate goal is the cultivation of such high value-added plants under any kind of environment."

In recent years, the effects of climate change have radically altered areas of land suitable for cultivation across the globe, with adverse impacts on crop yields and quality. The spread of technologies such as DSE, though, could quite literally change the landscape. While currently working with domestic construction companies and food manufacturers to develop greening components and crop cultivation methods using DSE, endophyte Inc. is also poised to expand its business overseas, including the ASEAN region, in the next few years. Kazaoka said, "We want to take on a broad range of challenges, from organic agriculture to plant factories and urban greening. Harnessing the power of DSE will not only take us from 'zero to one,' it opens up infinite possibilities to go even further."

Top: DSE is cultured in flasks while providing agitation, before being transferred to petri dishes for further culture.
Bottom: Agricultural materials containing DSE (pictured) are mixed into seedling soil and other growing media for use.