Wind erosion poses a significant challenge worldwide, affecting quality of life in regions such as the southwestern USA, western China, Saharan Africa, and much of the Middle East. Its impacts extend beyond environmental threats to dust-origins settlements, as it also disrupts infrastructure, industry, and resources. Financial losses in the aviation industry, damage to crop growth and yields, and the spread of dust-borne microorganisms causing health issues are all exacerbated by wind erosion.

In response to this pervasive issue, numerous soil stabilization techniques have been proposed. However, traditional methods and chemical mulches have been deemed unsustainable and environmentally unfriendly due to their high CO₂ footprint. As a result, innovative alternatives have emerged, such as biologically-induced calcite precipitation (MICP), enzyme-induced carbonate precipitation (EICP), and the use of biopolymers. This poster provides a brief review and analysis of these promising, eco-friendly solutions.

Biologically-induced calcite precipitation versus biopolymers

Ureolytic versus nonureolytic

In microbially induced calcite precipitation based on the ureolytic pathway, the ammonium ions produced during carbonate precipitation are considered an undesirable by-product when produced in large volumes. Therefore, the use of nonureolytic MICP in soil and wind erosion stabilization has been examined recently, and different calcium sources and microorganisms have been examined for stabilizing sand dunes against wind erosion [1], which have been proved to be promising:

Figure 2-3.

BICP=MICP and EICP

Having known that microbially induced calcite precipitation is mediated through the enzymes produced by bacteria, some studies have directly employed enzymes such as urease for calcium carbonate precipitation. EICP suffers a lack of nuclei. Other issues of concern are the stability of enzymes together with their workability (Figure 2: bacteria cells serve as a nucleus for calcium carbonate precipitation in MICP, contrary to EICP).

Biopolymers

While the research on biological soil stabilization is still active, the need for exo-cultivation of bacteria, the cost of enzymatic treatment, and practical hurdles have led scientists to explore the use of biopolymers, organic compounds which can be obtained from several waste sources such as paper and agricultural wastes, and carboxymethyl cellulose (CMC) [4] for wind erosion mitigation.

Takeaway messages/new directions

Given the global warming and CO₂ footprint of traditional materials, the use of bio-inspired methods for soil stabilization seems more appealing than ever. The use of waste resources for preparing the culture media of microorganisms, the biological stimulation of most proper indigenous bacteria and enzymes which can tolerate harsh conditions are new directions.

References