AgriCos e-Newsletter
ISSN: 2582-7049
AgriCos e-Newsletter
Open Access Multidisciplinary Monthly Online Magazine
Volume: 04 Issue: 01 January 2023 Article No: 04

Biological Soil Crusts: A Novelty in Dryland Ecosystems

Anandkumar Naorem and Saritha M.
Scientist, Division of IFS, ICAR-Central Arid Zone Research Institute, Jodhpur- Rajasthan

SUMMARY

Biocrusts, or biological soil crusts, are made up of organisms like fungi, bacteria, algae, and bryophytes (mosses, etc.) that colonise bare soil and bind it together by entangling soil particles in their rootlike filaments or by glueing them together with polysaccharide exudates. Biocrusts are prevalent in arid and semiarid locations, where vascular plant cover is naturally limited and hence direct sunlight may reach the ground more easily. They are, however, extremely significant, as they aid in soil stability and the acquisition and cycling of crucial soil nutrients and moisture. Carbon fixation, nitrogen fixation, and soil stabilisation are just a few of the ecological roles that biological soil crusts play. These crusts also affect soil albedo and water relations, as well as germination and nutrition levels in vascular plants. It may take a long time for them to return to normal after being injured by activities like fire, recreation, grazing, and other disturbances.

INTRODUCTION

Global population reached eight billion in 2019, as reported by the United Nations; the majority of these people (60% in Asia and 16% in Africa) live in arid or semiarid regions. Increases in agricultural output are primarily necessary to keep up with the needs of this rapidly expanding population. Therefore, in the next forty years, food and feed production must double to meet the rising demand. There is a wide range of variation in arid regions, from landforms and soils to flora and fauna to water cycles and human activity. There is a growing awareness of the challenges posed by arid farming, particularly in developing nations. One-third of the world's population resides in just 41% of its land area, and they rely on cereals and vegetables for the vast majority of their daily caloric intake. Drought, salinity, low or high temperatures, and other environmental extremes are just some of the abiotic stresses that pose serious problems for the living organisms (such as plants and bacteria) in these areas. Several variables, including strong wind erosion, sedimentation, daily temperature changes, and water shortage, contribute to the exceptionally dry soil seen in desert locations. Soil in most desert areas is dry and "Aridisol," with characteristics including a low nitrogen and organic matter content, a slightly alkaline pH, a high salt ions content, and a higher phosphate, calcium carbonate, and magnesium carbonate content. Aridity is expected to grow in some model scenarios, leading to widespread drought in several parts of the world.

Biological soil crusts (BSCs)

Biological soil crusts (BSCs) are a prominent feature of desert soils and other dry, arid soils with limited plant cover. It is estimated that biocrusts cover more than 12 percent of the Earth's terrestrial land surfaces and can reach as high as 70 percent in desert environments. Biocrusts have become an important and emerging research focus in recent decades due to their ecological and microbial characteristics, aligned with their ubiquitous occurrence in arid environments. These biocrusts address many research themes, such as stress survival, ecological assembly in harsh environments, and biogeochemical influence on their surrounding soils. Communities of living organisms in the soil's crust were more of a novelty than an essential part of dryland ecosystems. Numerous studies since then have shed light on various facets of these communities, revealing, for example, that biological soil crusts, despite their microscopic size, play a crucial role in numerous desert ecological processes. Significant ecological services provided by biocrusts include carbon (C) and nitrogen (N) fixation, enhancement of soil particle aggregation, reduction of soil erosion, regulation of soil hydrology, and promotion of vascular plant development. Nearly 46% of the world's N-fixation activity in terrestrial ecosystems may be attributable to biocrusts. Seed germination and establishment as well as local hydrological cycles are affected by their multiple effects on soil properties. Cyanobacteria, green algae, mosses, fungi, and lichens make up the crusts. Contrasting with the sand underneath or the mobile sand, the crust accumulates fine particles. To the northwest, in the Negev and Sinai, cyanobacteria clearly predominates all other crust organisms. The filamentous genera are one such group. The genus *Microcoleus* and the genus *Trichocoleus* appear to be the most significant in all crusts and to play a significant role as pioneer species in disturbed environments. Biocrust has been shown to have beneficial effects on the soil nutrients below. Soils in a sand dune system with biocrusts had more organic matter, total N, and available N than soils without biocrusts. While evidence for the leaching of accessible N from biocrusts is strong, it has not been consistently observed. As a result, the fate of biocrust N is still up for debate. More than 25 years ago, Jayne Belnap and colleagues investigated the significance of biocrusts in the nutritional status of vascular plants (e.g., Belnap and Harper 1995). In the recent decade, researchers have taken a more mechanistic approach, proposing that symbiotic fungi mediate carbon and nitrogen fluxes between plant and biocrust patches, thereby facilitating their functional integration. Dettweiler-Robinson (2018) examined whether biocrusts may utilise carbon from plants using field observations and stable isotope techniques. In sum, the research did not lend credence to the idea that biocrusts and vascular plants are functionally coupled in carbon cycling. The work, however, does suggest a number of alternate possibilities that can be tested and used to direct future investigation into this crucial area of plant-biocrust interactions.

CONCLUSION

The ecological significance of biocrusts, particularly their activities as microbial engineers in the revitalization of arid ecosystems, is gaining attention around the world. Understanding the functional roles of these crusts requires characterization of the bacterial populations within them, along with appropriate biogeochemical analysis. To date, the majority of research has isolated a single function (such as carbon fixation) or a single type of biological crust community. The next difficult step will be to research the crucial functions of biological soil crusts in ecosystems and to record and quantify the ecological services they provide. Taxonomy, physiology, carbon and nutrient cycles, and hydrology, among others, will need to work together toward this goal. In order to perform collaborative analysis and modelling of the results on greater sizes, we need to use similar approaches to answer specific concerns. Important research has to be done to determine how land use and climate change affect the ecological roles of biological soil crusts and the ecosystem services they supply.

REFERENCES

Belnap J, Harper KT (1995) Influence of cryptobiotic soil crusts on elemental content of tissue of two desert seed plants. Arid Soil Res Rehab 9:107–115

Dettweiler-Robinson E (2018) Biocrust carbon isotope signature was depleted under a C3 forb compared to interspace. Plant Soil. https://doi.org/10.1007/s11104-017-3558-5