**Brief information about the project**

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| Name of the project | AP13268305 «Development of an amendment based on low-rank coal and coal solubilizing bacteria for salt-affected soil remediation efficiency» (0122PK00094) |
| Relevance | Due to the rapid increase of soil salinization around the world, its potential management using lower cost and higher efficiency technologies is of great importance. The bioconversion of salinized land into healthy agriculture systems by utilizing low-rank coal (LRC) is a process of sustainable agricultural development goals. LRC inoculated with coal solubilizing bacteria may serve as the backbone of the organic amendment (humified organic matter – HOM) in salt-affected soil, where the microbial activity can take place to accelerate the LRC biotransformation to contribute to the land reclamation. |
| Purpose | To develop (1) a site-specific soil amendment of LRC (a) along with bacterial inoculation (b) that produces HOM through coal biosolubilization, and to study (2) its effect on physicochemical and biological properties of saline soils as well as (3) plant growth and yield responses under greenhouse and field conditions. |
| Objectives | - to streamline project management and generate research configuration, including planning, implementation, monitoring, logging, and process documentation. This step is critical to creating a strategy-based plan of action to achieve the goal.<br>- to collect and characterize LRC samples from different Kazakhstani coal deposits in terms of their disparate physicochemical features. Knowledge of LRC nature is important to formulate effective exploration and exploitation approaches.<br>- to isolate, screen, and analyze the indigenous-exogenous microbial samples from geographically distinct environments and gain insight into their ability to transform/solubilize LRC.<br>- to cultivate and maintain the isolated microbial groups using LRC of different origins as the sole carbon/energy source. Detailed studies on how microbial composition and abundance influence coal bioavailability will result in the generation of new strategies for improving the coal's metabolization rate and extent.<br>- to study the separate and combined effects of selected microbial communities on pretreatment and biotransformation of LRC. Understanding the growth conditions, microbial interactions and metabolic variability in microbial communities are conducive to coal biotransformation.<br>- to maintain, control, and evaluate the coal bioavailability under a set of test conditions; to determine the salt tolerance, biogeochemical indicators, metabolic pathways, and HOM biosynthesis; to analyze the relationship |

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| | between community composition, coal rank, and HOM production.<br>- to examine different operational/functional conditions and environmental factors to create the best biotransformation performance; to identify possible reasons for the cessation of HOM generation. This phenomenon is highly advantageous for applying LRC as a slow-release amendment.<br>- to optimize LRC biotransformation for achieving maximum productivity. The strategies include microbial and chemical stimulations and coal pretreatment.<br>- to select and combine the appropriate doses and ratios of LRC-coal solubilizing bacteria to create amendment variants (products).<br>- to apply the products to various soils with respect to pH under greenhouse conditions; to study the induced changes in the geobiological properties of the soil. In addition to the integrated (amendment) effects, the individual effects of LRC and coal solubilizing bacteria on soils will be tested.<br>- to carry out a comprehensive biochemical analysis to identify the effect of the products on soil microbial structure and dynamics, as well as soil-plant-microbe ecological interactions.<br>- to apply the products to potato growth and production under field conditions with salt-affected soils; to observe phenological stages, growth parameters, and production yield of potato; to conduct the physical and chemical quality analyses of potato tubers. |
| Expected and achieved results | The research project will result in the development of an effective soil amendment based on low-rank coal and coal solubilizing bacteria, which would be used as an accurate, safe, and cost-effective strategy to improve salt-affected soil health and increase potato yield. |
| Research team members with their identifiers (Scopus Author ID, Researcher ID, ORCID, if available) and links to relevant profiles | Tagaev Kuttymurat Zhurgenbayuly, Ph.D. Index H – 1, ORCID: 0000-0002-6436-6664, Researcher ID: IZJ-1952-2023 |
| List of publications with links to them | Nuraly S. Akimbekov, Ilya Digel, Kuanysh T. Tastambek, Kuttymurat Tagayev, Sholpan O. Bastaubayeva, Adel K. Marat. Utilization of Humic-Loaded Fly Ash as a Slow-Release Amendment for Soil Quality Improvement. ES Materials & Manufacturing, 2023, 22, 967. DOI: 10.30919/esmm967 |
| Patents | - |