Mars or Bust! A Method to Build a Martian Regolith-Based Substrate for Sustainable Agriculture on Mars

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To establish long-term human presence on Mars, a method for sustainable agriculture utilizing in-situ resources and minimal fostering materials from Earth must be developed. This study aimed to grow Trifolium repens in a Mars Global (Regolith) Simulant, or MGS-1, substrate that yields dry plant biomass statistically non-inferior to control plants grown in Earth soil. Previous research has established that growing plants in 100% MGS-1 is not possible. Previous studies combining regolith simulant with mixtures of 50% soil or more have produced plant biomass inferior to control biomass. Pre-experimental analysis of the chemical and physical properties of MGS-1 indicated that a variety of augmentation is needed to support agriculture in Martian regolith including acidification, nitrogen fortification, microbe introduction, humus creation and drainage. This experiment tested different methods including mixing MGS-1 with highly-expandable coco-coir (coconut waste) and minimal Earth soil as well as integration of plant biomass as biofertilizer for subsequent crops after each of four 12-week growth cycles. After growth cycle 1 (G1), fewer than half of the treatments survived and all were statistically lower in average dry biomass than the control ($p<0.01$). After G2, plant biomass increased significantly (>2X). After G3, one treatment combination surpassed the control in average dry biomass and the null hypothesis was rejected. This novel approach using just 4% Earth soil and a waste product is the first method to successfully grow plants in augmented MGS-1 non-inferior to Earth-grown crops. This ongoing research has applications on Earth to support declining ecosystems and mining restoration.

Awards Won:
Air Force Research Laboratory on behalf of the United States Air Force: Glass trophy and USAF medal for each recipient
Air Force Research Laboratory on behalf of the United States Air Force: First Award of $750 in each Regeneron ISEF Category,
Arizona State University: Arizona State University ISEF Scholarship (valued at up to $58,000 each)
Long Island University: Presidential Scholarships
Westlake University: Westlake University is awarding Pre-college Summer Program Scholarships, covering the program fee, lodging, food, insurance, round-trip international airfare, and excursions in Hangzhou &amp
Shanghai this summer, to two finalists. Outstanding students will be given priority with full scholarships for undergraduate admissions, applicable to any major, at Westlake University.