Popular Article

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Space Breeding

Latha G K[1*], Dr. Devaraju[2] and Chitra, K[3]

[1]PG Scholar, Department of Vegetable Science, College of Horticulture, Mudigere, KSNUAHS, Shivamogga (Karnataka), 577412

[2]Assistant Professor, Department of Vegetable Science, College of Horticulture, Mudigere, KSNUAHS, Shivamogga (Karnataka), 577412

[3]PhD Scholar, Department of Vegetable Science, College of Horticulture, UHS, Bagalkot (Karnataka), 587104

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Abstract

Space breeding is a technique that uses the genetic variations produced in plant seeds by the space environment to identify novel germplasm on the ground to develop new crop varieties (Liu *et al*., 2009). The plants grown from space flight have been exposed to cosmic radiation and microgravity. This has led to the generation of crop varieties with diverse genotypes and phenotypes arising from different cellular, subcellular, genomic, chromosomal and biochemical changes. DNA damage and chromosomal aberrations are the major factors responsible for genetic polymorphism and the generation of crops with modified genetic combinations. These changes can produce next-generation crop varieties capable of surviving diverse environmental conditions.

Introduction

Mutation breeding has been considered an important tool for plant breeders for more than 70 years to increase the genetic diversity of plants and derive new mutant lines with improved characteristics. The popularization and utilization of mutant varieties have contributed to food production and social and economic development. Mutation induction has become one of the most fruitful and widely used methods for crop improvement. In the last 20 years, new methods to induce mutation have been developed, and one such method is called space breeding.

Space breeding is a cutting-edge science that combines astronautics with agricultural sciences, aiming at space farming and space flight mutations. Space farming aims at growing plants in space. At the same time, the spaceflight-induced mutation technique is a technique that uses the genetic variations produced in plant seeds by the space environment that can be reached by recoverable spacecraft (such

as recoverable satellites and space shuttles) and high-altitude balloons to identify novel germplasm on the ground from which to develop new crop varieties (Liu *et al*., 2009).

Space

Space, also known as outer space, is the near-vacuum between celestial bodies. This is where all the planets, stars, galaxies and other objects are found. Extreme temperatures are seen from 2.6 Kelvin to 5.5 trillion Kelvin.

Space station

A space station, also known as an orbital station or an orbital space station, is a spacecraft capable of supporting a human crew in orbit for an extended period and is, therefore, a type of space habitat.

1. Mir (USSR)
2. ISS- International Space Station: It is a partnership between European countries (represented by ESA), the United States (NASA), Japan (JAXA), Canada (CSA) and Russia (Roscosmos). The International Space Station is the world's largest international cooperative program in science and technology.
3. Tiangong space station (China)

Space Farming

Combination of astronautics and agriculture for cultivating crops for food and other materials in space or on off-Earth celestial objects. In outer space, plants are typically grown in microgravity. Plants will play a critical life-supporting role in the survival of human beings on long-duration space missions, beginning pretty soon with a mission to Mars. So, we wonder if these plants are 'Alien Plants,' but NASA calls them 'Extra-terrestrial Plants.'

The need for plants in space

According to Stankovic *et al.* (2018), plants in space provide numerous benefits to the humans accompanying them.

1. Plants for food in space.
2. Plants for mental well-being.
3. Plants for the Bio regenerative life support systems.

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Significance of space breeding

- Space breeding is of great interest to the global scientific community, for the impact of microgravity and cosmic rays on organisms from the Earth needs to be explored more.
- With long-term human stays at the space station, researchers hope to conduct experiments to test a self-recycling ecosystem in space.
- This will support more deep-space explorations, including building a lunar research base and crewed missions to Mars.
- The world has to increase its agriculture production by 70% if it wants to feed an additional two billion people expected to live on the planet by 2050. (Xia *et al*., 2021)

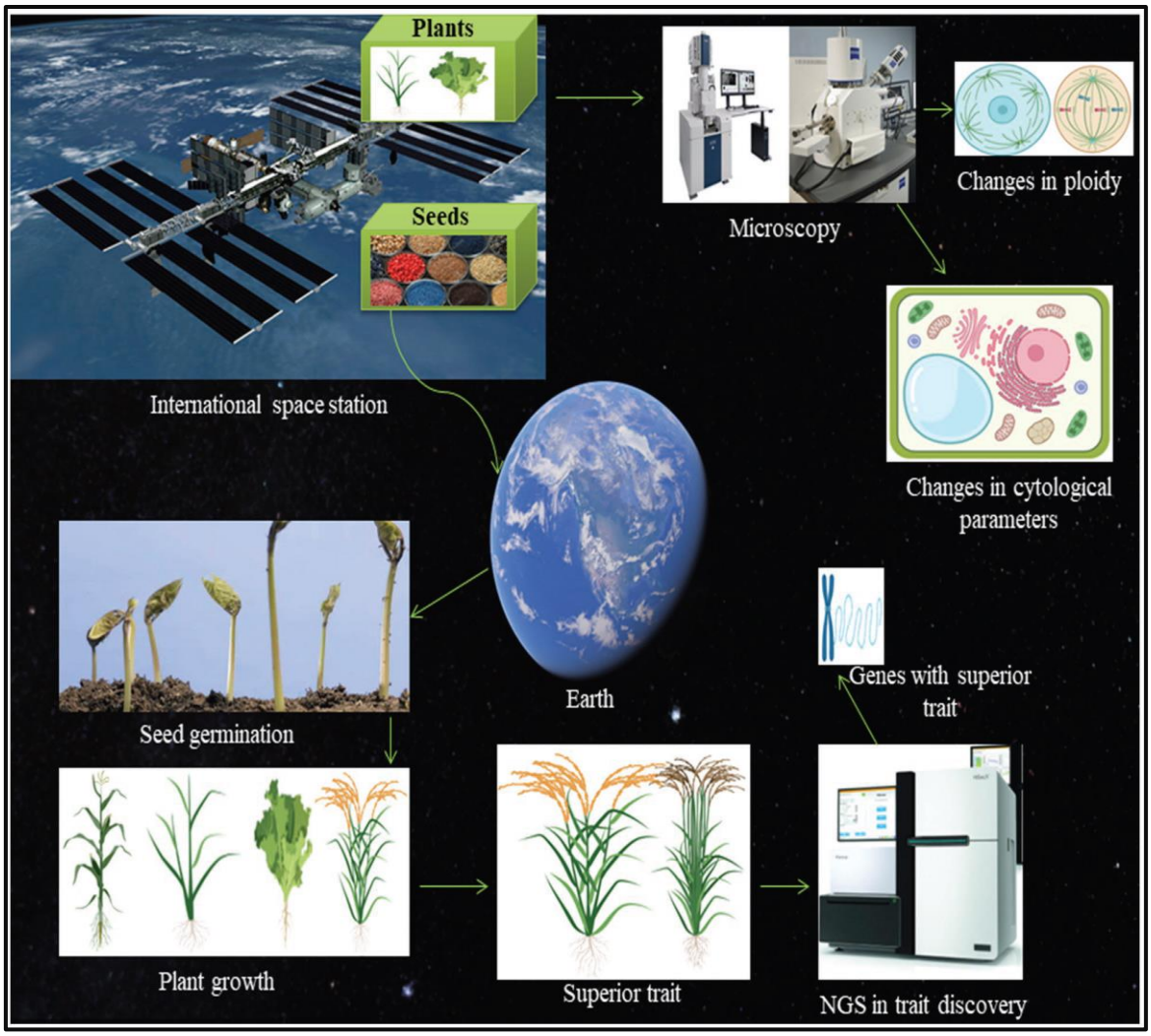

Figure. 1. Schematic representation of space breeding platform (Mohanta *et al*., 2021)

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Limitations of space breeding

- Research on space mutation is a costly affair.
- There has yet to be any thorough research on mechanisms, cytological and molecular genetic reasons involved in space mutation.
- Destruction of seed material in space, sterility and low germination percentage of space seeds.
- Concerns about the safety of 'space food.'
- Difficult to clarify the ownership of the variety and their intellectual property protection.
- Lack of popularization and industrialization.

Conclusion

Space-induced mutation technique is an effective new way not only to develop new crop varieties but also possible to obtain rare mutants that may make a great breakthrough in important economic characteristics of the crops, such as yield and quality, which are difficult to get using the other breeding methods on the ground. The research on the space-induced mutation technique's application needs to be strengthened. This method is limited because of the big investment and good technological support. However, a study on the simulation of space environment factors on Earth has a greater emphasis on future space breeding programs.

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