

## Brief Insights on Speed Breeding in Agriculture

Charu Bisht<sup>1</sup> and Amit kumar Gaur<sup>2</sup>

<sup>1</sup>Assistant Professor, Teerthanker Mahaveer University, Moradabad, Uttar Pradesh

<sup>2</sup>Phd GB Pant University of Agriculture and Technology Pantnagar, Uttarakhand

ARTICLE ID: 17

### Introduction

Speed breeding is a highly effective tool developed by NASA that expedites crop research and breeding efforts by significantly shortening the time it takes for generations of crops to develop. Traditional methods for crop improvement have been hampered by long breeding cycles, but speed breeding offers a solution to this problem. It is gaining widespread adoption in both large and small-scale agricultural units to enhance genetic gains in various crop species.

The benefits of speed breeding are numerous. It drastically reduces the time it takes to produce new generations of crops, allowing for more generations to be cultivated in a shorter timeframe. This rapid pace enables plant breeders to create new crop varieties more quickly, which is crucial for meeting the increasing demand for food in the future. Speed breeding can also be seamlessly integrated with modern crop breeding technologies such as high-throughput genotyping, genome editing, and genomic selection, further accelerating the rate of crop improvement. Additionally, it aids in expediting research related to adult plant characteristics, crossbreeding, mutants, and transformation, facilitating a deeper understanding of crop genetics and the development of desirable traits. Ultimately, speed breeding plays a role in achieving both nutritional security and sustainable agriculture by shortening breeding cycles for both food and industrial crops.

However, there are challenges associated with speed breeding. Precise control over environmental factors like temperature, humidity, and light is essential, and this can be difficult to achieve. The implementation of speed breeding can also be costly, as it requires specialized equipment and facilities. Moreover, there is a risk of reducing genetic diversity because of the rapid production of multiple generations of crops in a short span of time. Speed breeding is a promising approach to crop improvement, offering numerous advantages such as faster generation times, accelerated breeding programs, integration with modern technologies,



improved research, and support for sustainable agriculture. Nevertheless, it comes with challenges like the need for precise environmental control, high costs, and potential genetic diversity reduction.

### **Speed breeding in crops**

Accelerated breeding techniques have been employed in the cultivation of various crops to expedite the breeding process and create new crop varieties within a reduced timeframe. For instance:

- 1. Rice:** Japanese researchers have employed generation advancement methods to shorten the time required to develop new rice varieties.
- 2. Wheat:** The Hickey Lab in Australia has optimized speed breeding protocols for spring wheat, enabling the production of four to six generations of wheat plants in a single year.
- 3. Barley:** Speed breeding techniques have been utilized to facilitate the quicker development of new barley varieties.
- 4. Peas:** Speed breeding has been employed to expedite the creation of novel pea varieties.
- 5. Lentils:** Speed breeding techniques have been applied to accelerate the breeding process for new lentil varieties.

### **Speed breeding and varietal development-**

Speed breeding has brought about a noteworthy transformation in the realm of new crop variety development. By reducing the time required for generations and expediting the breeding procedure, it has empowered plant breeders to create fresh crop varieties in significantly shorter timeframes. This has played a crucial role in addressing the rising global food demand and enhancing food security.

Furthermore, speed breeding has facilitated the incorporation of contemporary crop breeding techniques, including high-throughput genotyping, genome editing, and genomic selection. This integration has further hastened the pace of crop enhancement. It has enhanced the efficiency of crop breeding programs and enabled the formulation of new crop varieties endowed with desirable characteristics.

Additionally, the advent of speed breeding has brought about a revolution on a global scale by diminishing generation timelines and expediting breeding and research initiatives geared towards enhancing crop varieties. Researchers now adopt a holistic approach to enhance



breeding efficiency, amalgamating speed breeding with existing plant breeding methods and genetic engineering. This strategy has enabled the swift development of superior plant varieties, offering a viable solution to food scarcity concerns and bolstering food security.

Nevertheless, it is imperative for governmental bodies to extend regulatory and financial support for the initiation and sustenance of speed breeding within public plant breeding programs. To expedite the production, evaluation, and commercial release of crop varieties, the amalgamation of speed breeding with other breeding techniques, alongside cost-effective high-throughput genotyping and phenotyping, is essential. In summary, speed breeding has left an indelible mark on the evolution of novel crop varieties by truncating generation periods, expediting the breeding process, and fostering the incorporation of contemporary crop breeding technologies. This has played a pivotal role in addressing the surging global food demand and enhancing food security. Nevertheless, ongoing governmental backing is required to uphold and further advance the utilization of speed breeding in public plant breeding programs.

#### **Speed breeding offers a range of solutions to tackle the pressing issues of climate change and food security:**

- 1. Enhancing Climate-Resilient Crops:** Speed breeding, when combined with advanced genomic and phenomic tools, enables the swift identification of genes, expediting crop improvement programs. This approach aids in the development of crops better suited to changing environmental conditions, thereby reducing the impact of climate change on crop yields.
- 2. Expediting Crop Improvement:** Speed breeding's ability to shorten breeding cycles accelerates the process of enhancing crop varieties. This faster turnaround time aids in meeting future food demands and enhancing food security.
- 3. Cost-Efficient Crop Improvement:** Speed breeding proves to be a cost-effective method for crop enhancement as it reduces the time and resources required for breeding programs. This affordability makes it more accessible to small-scale farmers and breeders.
- 4. Production of Superior Crop Varieties:** Speed breeding contributes to the development of improved crop varieties featuring desirable traits like disease



resistance, drought tolerance, and increased yields. This, in turn, elevates crop productivity and improves the livelihoods of farmers.

5. **Promoting Crop Diversity:** By utilizing speed breeding, new crop varieties can be generated for less-researched crops. This diversification augments food security and ensures a more sustainable and resilient food system.
6. **Integration with Artificial Intelligence:** Speed breeding can be seamlessly integrated with artificial intelligence to create climate-adaptive crops tailored to changing environmental conditions. This integration plays a crucial role in safeguarding global food security for the ever-expanding population.

In summary, speed breeding holds considerable promise in addressing climate change and food security challenges. Its applications encompass the development of climate-resilient crops, the acceleration of crop improvement, cost-effective enhancements, the creation of superior crop varieties, crop diversification, and integration with artificial intelligence. These applications collectively contribute to securing global food supplies and mitigating the impact of climate change on crop production.

#### **The Hickey Lab –**

Under the leadership of Dr. Lee Hickey, operates as a research team within the University of Queensland in Australia, specializing in the creation of novel crop varieties endowed with advantageous characteristics like disease resistance, drought resilience, and increased yields. One notable contribution of the Hickey Lab has been its pivotal role in formulating and disseminating speed breeding protocols, which enable the cultivation of up to six crop generations annually. These protocols have been particularly focused on optimizing the growth of wheat and barley, two of Australia's primary cereal crops.

Through their efforts, the lab has effectively harnessed speed breeding to generate new wheat and barley strains that exhibit sought-after attributes such as disease resistance, drought tolerance, and enhanced yields. Concurrently, they have undertaken genetic research to better understand disease and drought resistance in crops, with the aim of fortifying crops for the benefit of farmers. Furthermore, the Hickey Lab has been actively engaged in the integration of speed breeding with contemporary crop breeding technologies, including high-throughput genotyping, genome editing, and genomic selection. This integration serves to expedite the pace of crop improvement.



In summary, Dr. Lee Hickey's research group, the Hickey Lab, concentrates its efforts on the development of innovative crop varieties with favorable traits. Their significant contributions include the formulation and dissemination of speed breeding techniques, successful application of these techniques in wheat and barley breeding, genetic exploration of disease and drought resistance, and the integration of speed breeding with modern crop breeding technologies.

**Speed breeding comes with various potential disadvantages and constraints** -that require attention for its effective integration into agriculture. These encompass:

- 1. Facility Access:** Speed breeding necessitates specialized facilities with precise control over environmental factors like temperature, humidity, and lighting. Access to such facilities can pose challenges for small-scale farmers and breeders.
- 2. Trained Personnel:** Successful speed breeding demands personnel who are trained in the specific protocol. This can be problematic for smaller-scale farmers and breeders who may not have access to trained staff.
- 3. Departure from Traditional Breeding:** Speed breeding entails significant departures from conventional breeding methods, which can be challenging for breeders accustomed to traditional practices.
- 4. Diminished Genetic Diversity:** Speed breeding's rapid generation turnover can result in reduced genetic diversity. This may lead to the loss of critical genetic traits and a decrease in crop resilience to environmental stresses.
- 5. Plant Stress:** The accelerated growth pace in speed breeding can subject plants to stress, potentially impacting their growth and development. This stress may result in smaller plants and diminished yields.
- 6. Elevated Costs:** Implementing speed breeding can be costly due to the need for specialized equipment and facilities. This cost factor can be a hurdle for small-scale farmers and breeders lacking access to necessary resources.

In conclusion, speed breeding presents several potential drawbacks and limitations that must be addressed for its successful integration into agriculture. These issues encompass facility accessibility, skilled personnel, the shift from traditional breeding, reduced genetic diversity, plant stress, and high implementation costs. Addressing these challenges is crucial to



ensuring the effective implementation of speed breeding in agriculture and advancing food security.

### **Conclusion**

Speed breeding is a promising approach for achieving nutritional security and sustainable agriculture by shortening breeding cycles for food and industrial crop enhancement. This technique has several advantages, including shorter generation times, accelerated breeding programs, integration with other modern crop breeding technologies, improved research, and sustainable agriculture. Speed breeding has been successfully used on various crops, including rice, wheat, barley, peas, and lentils, to accelerate the breeding process and develop new crop varieties in a shorter period of time. However, there are also some challenges associated with speed breeding, including access to suitable facilities, staff trained in the protocol, adopting major changes to traditional breeding programs, reduction in genetic diversity, stressed plants, and high costs. Addressing these challenges can help to ensure the successful implementation of speed breeding in agriculture and improve food security. Speed breeding offers a compelling advantage over conventional plant breeding technology as it reduces the crop cycle by up to six generations per year. By lowering the amount of time, space, and resources invested in the selection and genetic progression of superior crop varieties, speed breeding can hasten the production of high-performing crops. Researchers are now using an integrated approach to improve breeding efficiency, combining speed breeding with current plant breeding and genetic engineering methods. In conclusion, speed breeding has the potential to revolutionize crop breeding and help meet the growing demand for food in the future. While there are some challenges associated with this technique, addressing these challenges can help to ensure the successful implementation of speed breeding in agriculture and improve food security.