International Research Journal of Plant Science (ISSN: 2141-5447)
Vol. 15(3) pp. 01-2, August, 2024
DOI: http:/dx.doi.org/10.14303/irjps.2024.40
Available online @ https://www.interesjournals.org/plant-science.html

Opinion

Gene Drives in Plant Breeding: Revolutionizing Crop Improvement

Shafi Bhuiyan Thapa*

Department of Genetics and Plant Breeding, Sylhet Agricultural University, Bangladesh

Email:sfi.byn@sau.ac.bd

INTRODUCTION

Gene drives are a groundbreaking genetic technology that allows specific genes to be passed down to nearly all offspring, rather than the typical 50% chance seen in traditional Mendelian inheritance. This mechanism offers tremendous potential in controlling pest populations, eradicating invasive species, and, more recently, revolutionizing plant breeding. By leveraging gene drives, researchers are working on new ways to enhance crop resilience, increase yields, and mitigate the impact of environmental stressors (Arora.,et al 2017).

A gene drive works by biasing the inheritance process. Normally, offspring inherit one gene from each parent, and there's a 50-50 chance for any particular gene to be passed down. Gene drives, however, disrupt this process by ensuring that a specific gene is inherited by more than 50% of the offspring—sometimes up to 100%. This is typically achieved using CRISPR-based techniques, where the gene drive ensures that both copies of the gene are altered, guaranteeing that the trait will be inherited (Barman.,et al 2020).

While gene drives have been extensively studied in insects for controlling vector-borne diseases like malaria, their application in plants is relatively new but equally promising. In plant breeding, gene drives can potentially be used to accelerate the development of desirable traits such as pest resistance, drought tolerance, or enhanced nutritional content (Borrelli.,et al 2018).

One of the most compelling applications of gene drives in plant breeding is the enhancement of pest and disease resistance. Many crops suffer from pests like insects, fungi, and bacteria, leading to significant yield losses. Conventional breeding methods and genetic modification have made strides in tackling these issues, but gene drives offer the potential for more targeted and lasting solutions (Doudna.,et al 2014).

For example, scientists could create a gene drive that spreads a pest-resistance trait across a crop population. This trait would rapidly propagate through multiple generations of the plant, effectively immunizing future crops against specific pests or pathogens ((Hartenian.,et al 2015).

With the increasing unpredictability of climate change, crop resilience to environmental stressors like drought and herbicides is critical. Gene drives could accelerate the development of crops that are more tolerant to such stresses. By introducing a gene drive that promotes drought tolerance, breeders could ensure that a larger percentage of plants inherit this trait, leading to more robust crops capable of thriving in arid conditions.Similarly, herbicide tolerance can be enhanced by gene drives, enabling crops to survive while controlling weeds more effectively. This can help farmers reduce their dependency on herbicides and make weed management more sustainable(Jiang.,et al 2017).

Gene drives also have the potential to enhance the nutritional quality of crops. For instance, biofortified crops with higher levels of essential nutrients such as vitamins, minerals, or protein could be developed faster using gene drives. The rapid propagation of these traits through crop populations could help combat malnutrition, particularly in developing regions where food security is a significant concern (T Yang.,et al 2023).

In agricultural ecosystems, the uncontrolled spread of weeds and invasive plant species can disrupt crop production and biodiversity. Gene drives could be used to introduce traits that suppress the growth or reproduction

Received: 30-July-2024, Manuscript No. IRJPS-24-149808; **Editor assigned:** 31-July-2023, PreQC No. IRJPS-24-149808 (PQ); **Reviewed:** 12-Aug-2024, QCNo. IRJPS-24-149808; **Revised:** 19-Aug-2024, Manuscript No. IRJPS-24-149808 (R); **Published:** 23-Aug-2024

Citation: Shafi Bhuiyan Thapa(2024).Gene Drives in Plant Breeding: Revolutionizing Crop Improvement.IRJPS. 15:40.

of invasive plants or harmful weeds. By targeting specific genes responsible for these plants' growth, researchers could effectively control or even eradicate troublesome species.Plants have more complex genomes compared to animals and insects, making it harder to develop effective gene drives. The presence of polyploidy (where plants have multiple sets of chromosomes) complicates gene editing because the gene drive must work across all copies of the gene (Mei.,et al 2016).

One of the biggest concerns is the risk of unintended consequences. Once released into the environment, a gene drive is self-propagating, and its effects may be difficult to control or reverse. This could lead to ecological disruptions, such as the spread of a trait that negatively impacts non-target species or harms biodiversity.In some cases, resistance to the gene drive may evolve over time. This occurs when mutations prevent the gene drive from functioning as intended. As a result, the drive may not be as effective in propagating the desired traits, diminishing its long-term impact (Singh.,et al 2017).

Gene drives are controversial due to the ethical and regulatory challenges they present. The irreversible nature of gene drives raises questions about who controls their use and how to prevent misuse. Additionally, there are concerns about the potential monopolization of this technology by large corporations, which could marginalize smallholder farmers and communities that rely on traditional farming methods.International frameworks and guidelines must be developed to ensure the responsible and equitable use of gene drives in agriculture. The involvement of stakeholders, including governments, scientists, and local communities, will be crucial in establishing ethical standards and ensuring transparency (Zhan.,et al 2019).

CONCLUSION

Despite the challenges, gene drives hold significant promise in transforming plant breeding and addressing some of the most pressing issues in global agriculture. Their potential to accelerate the development of crops with desirable traits such as pest resistance, drought tolerance, and improved nutritional content is unparalleled.To fully realize the benefits of gene drives, continued research is necessary to overcome technical challenges and address ethical concerns. Regulatory frameworks must evolve to balance innovation with environmental safety and social equity.

REFERENCES

A. (2018). The enhancement of plant disease resistance using CRISPR/Cas9 technology. *Frontiers in plant science*, *9*, 1245.

Arora, L., & Narula, A. (2017). Gene editing and crop improvement using CRISPR-Cas9 system. *Frontiers in plant science*, *8*, 1932.

Barman, A., Deb, B., & Chakraborty, S. (2020). A glance at genome editing with CRISPR–Cas9 technology. *Current genetics*, *66*, 447-462.

Borrelli, V. M., Brambilla, V., Rogowsky, P., Marocco, A., & Lanubile, Cas9 therapeutics: progress and prospects. *Signal Transduction and Targeted Therapy*, *8*(1), 36.

Doudna, J. A., & Charpentier, E. (2014). The new frontier of genome engineering with CRISPR-Cas9. *Science*, *346*(6213), 1258096.

Hartenian, E., & Doench, J. G. (2015). Genetic screens and functional genomics using CRISPR/Cas9 technology. *The FEBS journal*, *282*(8), 1383-1393.

Jiang, F., & Doudna, J. A. (2017). CRISPR–Cas9 structures and mechanisms. *Annual review of biophysics*, *46*(1), 505-529.

Mei, Y., Wang, Y., Chen, H., Sun, Z. S., & Ju, X. D. (2016). Recent progress in CRISPR/Cas9 technology. *Journal of Genetics and Genomics*, *43*(2), 63-75.

Singh, V., Braddick, D., & Dhar, P. K. (2017). Exploring the potential of genome editing CRISPR-Cas9 technology. *Gene*, *599*, 1-18.

T Yang, Y., Qi, H., Cui, W., Zhang, L., Fu, X, et al,.(2023). CRISPR/Cas9 therapeutics: progress and prospects. *Signal Transduction and Targeted Therapy*, *8*(1), 36.

Zhan, T., Rindtorff, N., Betge, J., Ebert, M. P., & Boutros, M. (2019, April). CRISPR/Cas9 for cancer research and therapy. In *Seminars in cancer biology* (Vol. 55, pp. 106-119). Academic Press.