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Genetically Modified Crops: Resistant To Pest And Environmental Stress: A Review

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Abstract

Genetically modified crops (GMCs) have emerged as a revolutionary force in agriculture, offering promising solutions to address global challenges such as food security, environmental sustainability, and economic viability. The overview of genetically modified crops, encompassing their development, benefits, concerns, and future prospects. Genetically modified crops are created through the incorporation of specific genes from one organism into another to confer desirable traits, such as resistance to pests, diseases, and environmental stresses, or enhanced nutritional profiles. The development of GMCs involves advanced biotechnological techniques, including gene editing tools like CRISPR-Cas9 and traditional methods like selective breeding. The benefits of genetically modified crops are multifaceted. Improved yield and crop resilience contribute to increased food production, addressing the growing global population's nutritional needs. Resistance to pests and diseases reduces the reliance on chemical pesticides, promoting environmentally friendly and sustainable agricultural practices. Additionally, some GMCs are designed to withstand harsh environmental conditions, such as drought or soil salinity, expanding the range of cultivable land.

However, the widespread adoption of genetically modified crops has sparked debates and raised concerns. Environmentalists express apprehension about potential ecological impacts, including the unintentional spread of modified genes to wild plant populations and the development of resistance in target pests. Socioeconomic issues, such as intellectual property rights and corporate control over seeds, have also been contentious topics. To address these concerns, ongoing research focuses on refining the safety assessment protocols for genetically modified crops, implementing responsible and transparent regulatory frameworks, and conducting long-term environmental impact studies. Public awareness and engagement play a crucial role in shaping the ethical, legal, and social aspects surrounding genetically modified crops. Looking ahead, the future of genetically modified crops holds promise for addressing emerging challenges in agriculture. Continued

	advancements in gene editing technologies, increased understanding of plant genetics, and collaboration among scientists, policymakers, and communities can pave the way for innovative solutions. Striking a balance between harnessing the benefits of genetically modified crops and addressing ethical and environmental considerations will be paramount for realizing their full potential in global agriculture. ***Keywords: Transgenic crops, insect, environment, strsses***

Introduction

Genetically modified crops, often referred to as GM crops or biotech crops, represent a significant technological advancement in agriculture that has sparked widespread debate and discussion. The introduction of genetically modified organisms (GMOs) into crop cultivation has been a transformative force, promising to address various challenges in global food production, enhance nutritional content, and mitigate environmental impacts. This technology involves the manipulation of an organism's genetic material, typically through the introduction of specific genes or alterations to existing ones, with the aim of conferring desirable traits. The development of genetically modified crops began in the 1980s when scientists harnessed the tools of genetic engineering to modify the genetic makeup of plants (Grifths *et al.* 2005).

This approach allowed for the precise introduction of desired traits, such as resistance to pests, diseases, or herbicides, improved nutritional content, and increased tolerance to environmental stresses like drought or extreme temperatures. The first commercially available genetically modified crop was the Flavr Savr tomato (Animasaun, *et al.*2023), which was engineered for delayed ripening and enhanced shelf life. Since then, the scope and variety of genetically modified crops have expanded significantly. Some of the most widely adopted GM crops include soybeans, corn, cotton, and canola . These crops are often engineered to express traits that benefit both farmers and consumers. For instance, insect-resistant crops produce their own pesticides, reducing the need for external chemical applications. Herbicide-tolerant crops allow for more effective weed control, facilitating simplified and efficient farming practices.

Proponents of genetically modified crops argue that these technologies offer a powerful solution to the challenges of global food security. With a rapidly growing world population and changing climatic conditions, there is an increasing need for crops that can withstand environmental stressors and produce higher yields. GM crops have the potential to improve agricultural productivity, reduce reliance on chemical inputs, and enhance the nutritional quality of food.

However, the widespread adoption of genetically modified crops has also raised ethical, environmental, and socio-economic concerns. Critics express apprehension about the potential long-term environmental impacts of genetically modified organisms, the consolidation of seed patents in the hands of a few multinational corporations, and the potential for unintended consequences on non-target organisms.

The debate over genetically modified crops extends beyond scientific and technical considerations, involving complex issues related to ethics, socio-economic equity, and environmental sustainability. Striking a balance between harnessing the benefits of genetic engineering for agriculture and addressing the concerns raised by skeptics remains a challenging task for policymakers, scientists, and the agricultural industry at large.

As the field of biotechnology continues to advance, the future of genetically modified crops will likely be shaped by ongoing research, technological innovations, and a comprehensive understanding of their broader implications. The conversation surrounding GM crops reflects the intersection of science, ethics, and policy, emphasizing the need for a nuanced and informed approach to ensure the responsible development and deployment of this transformative technology.

Methods

Genetically modified (GM) crops, also known as genetically engineered (GE) crops, involve the manipulation of an organism's genetic material to achieve desired traits. There are several methods used in the creation of genetically modified crops. Here are some common techniques:

Agrobacterium-mediated gene transfer:
Agrobacterium tumefaciens is a naturally occurring bacterium that can transfer genes into plants. Desired genes are inserted into a plasmid, which is then introduced into *Agrobacterium. Agrobacterium* infects plant cells and transfers the genes into the plant genome.

Particle bombardment (gene gun method):
Tiny gold or tungsten particles coated with the desired genes are shot into plant cells using a "gene gun." This method allows for the direct delivery of genes into the plant cell nucleus.

Electroporation:
Electrical fields are used to create temporary pores in the cell membrane, allowing the entry of foreign DNA. This method is particularly useful for protoplasts (plant cells with the cell wall removed).

CRISPR-Cas9 gene editing:
The CRISPR-Cas9 system allows for precise modification of the plant genome. Cas9, a molecular scissors enzyme, is guided to the target DNA sequence by a synthetic RNA molecule, where it induces cuts. The cell's repair machinery then fixes the cut, potentially introducing desired genetic changes.

RNA interference (RNAi):
Small RNA molecules are used to silence or inhibit the expression of specific genes. This method is often employed to enhance resistance to pests or diseases.

Protoplast fusion:
Protoplasts (plant cells with the cell wall removed) from different plant species are fused to create hybrid plants. This method is used for traits that may not be easily transferred through traditional breeding.

Gene stacking:
Multiple genes with desired traits are introduced into a plant to create a crop with several beneficial characteristics. This approach is often used to develop crops with resistance to multiple pests or improved nutritional content.

Site-directed mutagenesis:
Specific changes are made to the DNA sequence of a target gene without introducing foreign genes. Techniques like zinc-finger nucleases (ZFNs) or transcription activator-like effector nucleases (TALENs) are used for targeted modifications.
It's important to note that while these methods have been used to create genetically modified crops, public opinion and regulatory frameworks regarding GMOs vary globally. Some people and countries have embraced GM crops for their potential benefits, such as increased yield and resistance to pests, while others raise concerns about environmental impact, human health, and ethical considerations.

Table-1: Top GM crop growing countries

S. No.	Country	Area Cultivated with GM Crops (M.ha.)	Reference
1.	United States	70.	https://en.wikipedia.org/wiki/List_of_genetically_modified_crops https://royalsociety.org/topics-policy/projects/gm-plants/what-gm-crops-are-currently-being-grown-and where/#:~:text=Among%20the%20countries%20growing%20GM,leading%20country%20(0.1%20Mha)
2.	Brazil	44.2	
3.	Argentina	24.5	
4.	India	11.6	
5.	Canada	11.0	
6.	China	3.70	
7.	Paraguay	3.60	
8.	Pakistan	2.90	
9.	South Africa	2.30	
10.	Uruguay	1.40	

Graph-1: Top GM crop growing countries

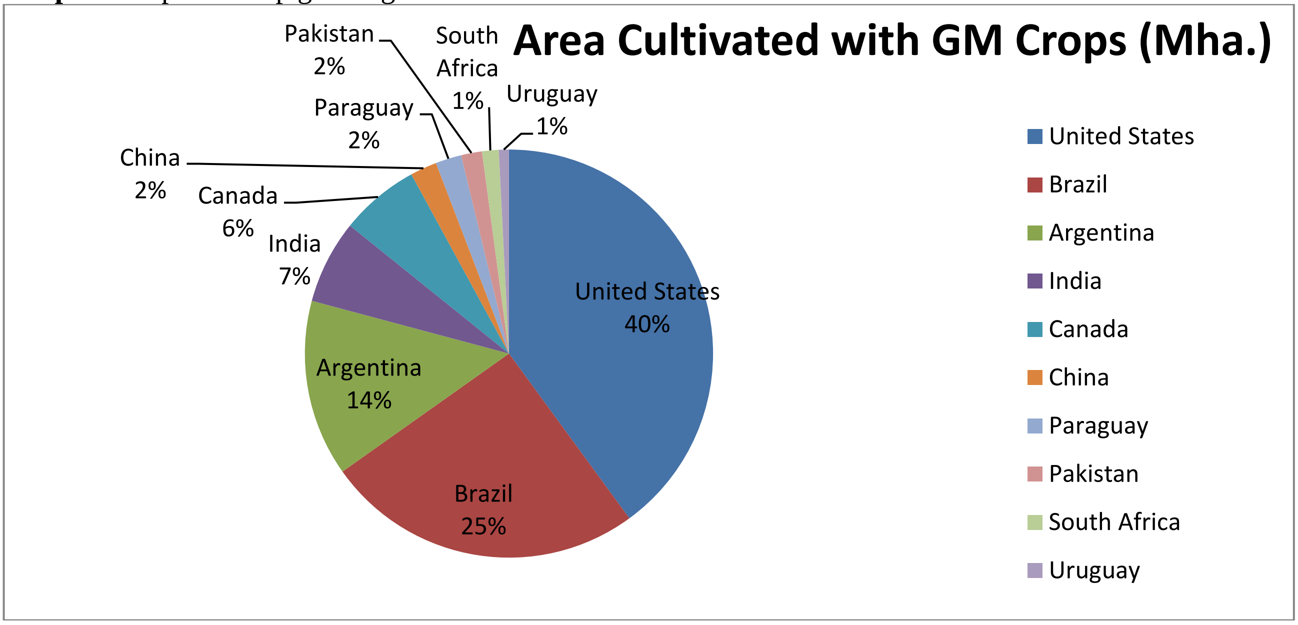

Table -2: Genetic modified crops and gene

S.No.	Crop	Gene	Reference
1.	**Bt cotton**	*Bacillus thuringiensis* (Bt) gene	Dale, P.J., 1993
2.	Roundup Ready Soybean, Corn, and Cotton	Glyphosate tolerance gene, 5-enolpyruvylshikimate-3-phosphate synthase (EPSPS gene),	Achary, M.M.V. *et al.*,2020. And Dill *et al.* 2008.
3.	Golden Rice	Beta-carotene biosynthesis genes (from *daffodil* and *bacterium*)	Beyer, P., *et al.* 2002.
4.	Eggplant	*Bacillus thuringiensis* (Bt) gene	Ibrahim, M.A. *et al.* 2010.
5.	Flavar savr Tomato	Antisense RNA to delay ripening	Animasaun, *et al.*2023

Conclusion

The development and adoption of genetically modified crops resistant to pests and environmental stress have the potential to address pressing global challenges related to food security and agricultural sustainability. However, it is essential to carefully consider and manage the associated risks and concerns, ensuring that the benefits are balanced with ethical, environmental, and health considerations. Ongoing research, transparency, and public engagement are crucial elements in making informed decisions about the use and regulation of GM crops. Ultimately, a nuanced and cautious approach is necessary to harness the potential benefits of this technology while minimizing potential drawbacks.

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Manuscript preparation and wrote the manuscript: Dr. Sharvan Kumar
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Conflicts of Interest

The author's declare's that there are no conflict of interest regarding the publication of this paper.

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