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GM Mustard: The Future of Oilseed Farming in India

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ABSTRACT

Genetically modified mustard, particularly the variety developed by Indian researchers known as DMH-11, has garnered significant attention for its potential to enhance agricultural productivity and sustainability. This genetically engineered crop incorporates a gene from the soil bacterium *A. tumefaciens*, allowing for increased oil content and resistance to certain diseases. Proponents argue that GM mustard can help improve yield in the face of climate change and rising food demand, while also reducing the reliance on chemical pesticides.

INTRODUCTION

Genetically modified plants are the plants whose genomes have been altered by inserting one or more genes from another organism, usually to confer a desirable trait that would not be possible through conventional breeding. For example, some genetically modified plants are resistant to pests, diseases, herbicides, or environmental stress. Genetically modified plants can also be used for scientific research, to create new colours, or to produce vaccines or other useful substances (Bhargava *et al.*).

Earlier, India approved the commercial cultivation of only one GM crop, Bt-cotton, but Genetic Engineering Appraisal Committee (GEAC) has recommended GM Mustard for commercial use.

What is GM Mustard?

- One of the latest examples of genetically modified plants in India is GM mustard **DMH-11**, which has been recently cleared for commercial cultivation by the Genetic Engineering Appraisal Committee (GEAC) under the Environment Ministry.DMH-11 is an indigenously developed transgenic mustard. It is a genetically modified variant of Herbicide Tolerant (HT) mustard.
- GM mustard was developed by a team of scientists from Delhi University, led by Prof. **Deepak Pental.**
- DMH-11 is a result of a cross between Indian mustard variety 'Varuna' and East European 'Early Heera-2' mustard.
- It contains two alien genes ('barnase' and 'barstar') isolated from a soil bacterium called *Bacillusamyloliquefaciens* that enable breeding of high-yielding commercial mustard hybrids.
- Barnase in Varuna induces a temporary sterility because of which it can't naturally self-pollinate. Barstar in Heera blocks the effect of barnase allowing seeds to be produced.
- DMH-11 has shown approximately 28% more yield than the national check and 37 % more than the zonal checks and its use has been claimed and approved by the GEAC.
- "Bar gene" maintains the genetic purity of hybrid seed.

Why is the Barnase/Barstar System Required?

- The hybrid seed production requires an efficient male sterility and fertility restoration system.
- The Barnase/Barstar system is a genetic modification technology that has been used in the development of genetically modified (GM) mustard plants. GM mustard refers to mustard plants that have been genetically engineered to exhibit specific traits, typically for improved agronomic performance (Patel *et al.*).
- In the case of GM mustard, the Barnase/Barstar system is employed to achieve male sterility in the plants. Male sterility is a desirable trait in hybrid seed production because it prevents self-pollination, ensuring that farmers have to buy new seeds for each planting season. This is advantageous for seed companies as it helps maintain the purity and performance of the hybrid variety.
- By using the Barnase/Barstar system, GM mustard plants can be engineered to be male sterile, ensuring that they cannot self-pollinate. To produce seeds, farmers can then use another line of mustard plants that contain the Barstar gene to provide the necessary protection against the toxic effects of Barnase during seed production. The resulting hybrid seeds will have the desired traits and characteristics, encouraging farmers to purchase new seeds for each planting season.
- The currently available conventional cytoplasmic-genetic male sterility system in mustard has limitations of breakdown of sterility under certain environmental conditions leading to lowering of seed purity.

Why GM Mustard is Necessary?

- India's import of edible oils is on continuous rise to meet the domestic demand. It ultimately led reduction forex. GM Mustard is essential to reduce the forex drain on Agri-import.
- Productivity of oilseed crops viz., soybean, rapeseed mustard, groundnut, sesame, sunflower, safflower and linseed in India is much lower than the global productivity of these crops.
- Crossing of genetically diverse parents results in hybrids with increased yield and adaptation.

What are the Safety Concerns associated with DMH-11?

- The safety of three genes used in the creation of the technique Barnase, Barstar and Bar is being questioned.
- Field trials for three years (two years of BRL-I and one year of BRL-II) have been conducted to assess the impact on human health and environment as per the stipulated guidelines and applicable rules (Pental *et al*.).
- It is important to note that comprehensive research on the toxicity, allergenicity, compositional analysis, field trials, and environmental safety studies of GM mustard has shown that they are safe for food and feed usage as well as for production.
- DMH-11 has "Bar gene" which is responsible for herbicide tolerance. Effectiveness of "Bar Gene" is under question as per herbicide tolerance is concerned (Farhan *et al*.).

What is the Significance of Genetically Modified Crops?

- Crossing of genetically diverse plants results in hybrids with increased yield and adaptation, a phenomenon known as hybrid vigor heterosis which has been widely exploited in crops like rice, maize, pearl millet, sunflower and many vegetables.
- It has been convincingly demonstrated that hybrids in general show 20-25% higher yield over the conventional varieties across the crops.
- Hybrid technology can play an important role in enhancing the productivity of rapeseed mustard in the country.

Impact of GM Mustard on Agriculture:

1. **Increased Yield:** One of the primary objectives of developing GM mustard varieties is to enhance crop yield. By introducing genes that improve resistance to pests or environmental stress, GM mustard may contribute to higher productivity.
2. **Pest Resistance:** GM mustard can be engineered to resist certain pests, reducing the need for chemical pesticides. This can lead to decreased production costs and potentially lower environmental impact.
3. **Improved Environmental Sustainability:** If GM mustard requires fewer chemical inputs, it may contribute to more sustainable agricultural practices, with reduced environmental pollution and a smaller ecological footprint.
4. **Adaptation to Climate Change:** GM mustard can be designed to withstand harsh environmental conditions, such as drought or extreme temperatures, making it a potential tool for addressing challenges posed by climate change.

CONCLUSION:

India's future in genetically modified mustard holds significant promise, particularly in addressing the challenges of food security, edible oil dependence, and agricultural productivity. However, the road ahead is fraught with challenges that must be carefully navigated. Striking a balance between innovation and sustainability, ensuring the safety and well-being of farmers, and fostering public trust will be key to determining whether GM mustard can play a transformative role in India's agricultural landscape. The ultimate success of GM mustard will depend on how effectively India can integrate scientific advances with the needs and concerns of its farmers, consumers, and environment.

Controversies and Moratoriums associated with GM Crops in India:

2002 – Bt cotton introduced in India.

2006 – Activists filed a PIL against GM crops in the Supreme Court.

2010 – The then environmental minister Jairam Ramesh blocked the release of Bt Brinjal until further notice owing to a lack of consensus among scientists and opposition from brinjal-growing states. No objection certificates from states were made mandatory for field trials.

2012 – Parliamentary standing committee on agriculture, in its 37th report asked for an end to all GM field trials in the country.

2013 July – New crop trials have been effectively on hold since late 2012, after a supreme court-appointed expert panel recommended suspension for 10 years until regulatory and monitoring systems could be strengthened. Though the SC panel suggested moratorium on GM trails, there was no official verdict from the Supreme Court on this issue.

2013 July – Environment minister Jayanthi Natarajan put on hold all trials following SC panel suggestions.

2014 – Her successor, Veerappa Moili cleared the way for trails. (NB: Two of Manmohan Singh's own environment ministers had stalled GM trials earlier, but Veerappa Moily took an opposite stand and the process of approving the one-acre field trials restarted.)

2014 July – 21 new varieties of genetically modified (GM) crops such as Rice, Wheat, Maize and Cotton have been approved for field trials by the NDA government in July 2014. The Genetic Engineering Appraisal Committee (GEAC) consisting mostly of bio-technology supporters rejected just one out of the 28 proposals up for consideration. Six proposals were rejected for want of more information.

2016: GEAC gave green signal to GM Mustard for field trial, but SC stayed the order and sought public opinion on the same.

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