Gene-edited Mustard

Why in news?

Recently, Indian scientists have developed the first ever low-pungent mustard that is pest and disease-resistant.

What is mustard?

> *India is the 4th largest oilseeds producer in the world. It has 20.8% of the total area under cultivation globally, accounting for 10% of global production.*

- Mustard is a self-pollinating oilseed crop.
- **Family** - Brassicaceae
- **Types**
  - White or Yellow mustard (*Sinapis alba*) - Mediterranean origin
  - Brown or Indian mustard (*Brassica juncea*) - Himalayan origin
- The seeds contain about 30-40% vegetable oil, a slightly smaller proportion of protein, and a strong enzyme called ***myrosin.***
- **Production - *Rajasthan*** is the largest producing state in the country.
- Other mustard cultivating states- Gujarat, Uttar Pradesh, West Bengal, Haryana, Punjab, Madhya Pradesh.
- **Issues**- Mustard seeds have high levels of glucosinolates, a group of sulphur and nitrogen-containing compounds that contribute to the ***characteristic pungency*** of their oil and meal.
- This limits the oil's acceptability among consumers.
- Rapeseed meal is ***unpalatable to poultry and pigs*** thus reducing their feed intake.
- High glucosinolates are also known to cause goiter (swelling of neck) and internal organ abnormalities in livestock.
- The ***canola quality*** seeds have low glucosinolates (30ppm). However, lowering of glucosinolate levels in seed weakens its defence.

What is Genome editing?

- **Genome editing** – It involves the use of technologies that *allow genetic material to be added, removed, or altered at particular locations* in the genome.
- It is a group of technologies that enables change in the DNA/RNA of an organism.
- It could introduce specific foreign DNA/RNA that is not available in the natural gene pool of the host plant species thereby introducing novel traits.
- **Objectives**
  - Crop improvement
  - Nutrition enhancement

- Crop protection from drought, pests and insects

How gene edited mustard is produced?

Nobel Prize in Chemistry was awarded to Emmanuelle Charpentier and Jennifer Doudna in 2020 for their work in CRISPR/CAS9.

- Glucosinolates are synthesised in the leaves and pod walls of mustard plants.
- Their translocation and accumulation in the seeds happens through the action of ***glucosinolate transporter or GTR genes.***
- ***CRISPR/Cas9,*** a gene-editing tool deploying an enzyme, acts as a "molecular scissors" to edit 10 out of the 12 GTR genes in 'Varuna', a high-yielding Indian mustard variety.
- The seeds of the resultant gene-edited Varuna variety had glucosinolate content below the 30 ppm canola-quality threshold.
- At the same time, the other plant parts had significantly higher glucosinolate accumulation.

CRISPR Cas-9
• It stands for Clustered Regularly Interspaced Short Palindromic Repeats. • It is the most prominent technology that enables to edit parts of the genome by removing, adding or altering sections of the DNA sequence. • The CRISPR-Cas9 system consists of two key molecules that introduce a change mutation into the DNA. • **Cas9-** An enzyme that acts as a pair of 'molecular scissors' that can cut the two strands of DNA at a specific location in the genome. • **Guide RNA (gRNA)-** The gRNA is designed to find and bind to a specific sequence in the DNA. • The Cas9 follows the guide RNA to the same location in the DNA sequence and makes a cut across both strands of the DNA. • At this stage, the cell recognises that the DNA is damaged and tries to repair it. • The DNA repair machinery is used to introduce changes to one or more genes in the genome of a cell of interest.

What are the advantages of gene edited mustard?

- **Canola quality mustard**- The seeds of the resultant targeted genes-edited Varuna mustard variety had glucosinolate content well below the 30 ppm canola-quality threshold.
- **Pest and disease resistance** - They were resistant against the virulent fungal pathogen *Sclerotinia sclerotiorum* and the insect pest *Spodoptera litura.*
- **Transgene free-** It does not contain foreign genes like those of the Bacillus thuringiensis bacteria in Bt-cotton or Bar-Barnase-Barstar in the GM hybrid mustard.
- **Reduce import bill-** India is a huge importer of edible oils. Gene edited mustard helps in saving foreign exchange reserves.
- **Indigenization-** There is a dire need to boost domestic oilseeds production through focused breeding for improving crop yields, pest and disease resistance, and product

quality.

- **Wider cultivation-** Mustard and soyabean are India's most widely-cultivated oilseed crops.
- Its higher average oil extractable content makes mustard the bigger "oilseed" crop.
- **Food security-** It is the source of both fat for humans and protein for animals.

How gene editing is different from gene modification?

About	Genome modification	Genome editing
Definition	Deliberate modification of the characteristics of an organism by manipulating its genetic	Artificial alteration of the genetic material of an organism to produce desired characteristics
Presence of Foreign DNA	Involves introduction of foreign DNA	Does not involve introduction of foreign DNA
Procedure	Targeted removal of desired genes	Addition, removal and alteration of genetic material.
Regulations	Genetic Engineering Appraisal Committee (GEAC) gives the clearance. Union Government takes the final decision.	Ministry of Environment exempted GE plants "free of exogenous introduced DNA" from the requirement of GEAC approval for open field trials leading to commercial release.
Example	Golden rice, Bt- Cotton, GM Mustard etc.,	Gene edited mustard

Reference

1. Indian Express- Gene edited Mustard

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