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The Dawn of Designer Crops: Cultivating a Future of Innovation in Agriculture

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Aman Srivastava[1], Avdhesh Kumar[2], Prabhat Kumar[3], Jainendra Pratap[4]

[1,4]Research Scholar Department of Genetics and Plant Breeding, ANDUAT, Kumarganj, Ayodhya (Uttar Pradesh)

[2,3]Research Scholar Department of Fruit Science, ANDUAT, Kumarganj, Ayodhya (Uttar Pradesh)

Designer crops are crop kinds that have been created to express a particular desirable monogenic, oligogenic, or polygenic characteristic. Transgenic plants are not the only ones covered by the term "designer crops." In actuality, cultivars created via any methodology including MAS are referred to as "designer crops" as long as they display a particular phenotype. For example, insect resistant varieties of maize and cotton are designer crops; they are produced by the integration of the *cry* gene from *Bacillus thuringiensis* into the genomes of these crops and an efficient expression of this gene to generate resistance to the target insects. Similarly, pyramiding of multiple QTLs/genes from different donors into a recurrent parent through MABC would yield “designer crops,” e.g., Improved Pusa Basmati 1 variety of rice. The transgenic and molecular marker technologies are the two potent approaches for a planned and precise transfer of genes to generate plant varieties having the specified set of, often novel, features.

Need for Designer Crop

- The world human population had been increasing at a rapid rate.
- Thus, the genetic improvement of crops seems to be the most viable approach to enhance agricultural production.
- Increasing crop areas may be expected to be diverted for cultivation of designer crops for producing specific biochemical.
- Thus, the traditional breeding programs do not seem to be capable of meeting the projected demands for agricultural production.
- It has been suggested that exploitation of the genomic resources by the transgenic and the

molecular marker technologies might offer solutions to the current challenges in plant breeding.

How to Develop Designer Crops

For designing future crops, the following approaches can be used,

1. Transgenics
2. Marker assisted backcrossing (MABC)
3. Marker assisted recurrent selection (MARS)
4. Haplotype based breeding (HBB)
5. Genome Editing
6. Speed GS

Designer Oilseed Crop

The main purpose of oilseed crops is to produce edible oil. The need for oilseeds' nutritious vegetable oils, animal feed, medicines, biofuels, and other oleochemical industrial applications has increased recently, drawing more attention to them. The increased interest resulted in an 82% expansion of oilseed crop cultivation areas and about a 240% increase in total world production over the last 30 years. Thus, in order to increase oil yield per unit area and meet the growing global demand, traditional breeding methods must be combined with biotechnological techniques to achieve sustainable oil production. One such strategy to address this rising need is to expand the areas where oilseeds are grown. Through genetic engineering, oilseed crops can be produced sustainably and with improved quality and nutritional value for industrial use. TAGs, composed of various fatty acids, are the main component of vegetable oil. Many genes in TAG biosynthesis pathways have been identified and studied well. New biotechnology approaches enable the insertion or alteration of genes involved in the biosynthesis of a desired fatty acid, allowing for the accumulation of a larger amount of fatty acid or even the production of a unique fatty acid. Global possibilities for the sustainable production of oilseed crops have been made possible by genetic engineering, which also ushered in a new era for designer oil crops.

- ❖ Several genes in the fatty acid biosynthesis pathway, such as thioesterases, transacylases, desaturases, and desaturase-related enzymes, were cloned and transformed into oilseed crops leading to the production of designer oil crops.
- ❖ In cotton, utilized hairpin RNA-mediated, post transcriptional gene silencing to modify the stearic and oleic acid content.
- ❖ Utilizing RNAi silencing, allowed to generate transgenic *B.napus* lines with decreased lignin contents up to 40% relative to wild types.
- ❖ High oleic acid (84–88%) transgenic soybean was also generated using sense Fad2-1 by means of microprojectile bombardment.

Future Prospective

- ➢ The integration of genetic resources and transformational capacities, such as genomic breeding and synthetic biology, will be crucial in customizing crops to enhance food security and reduce the ecological footprint of agriculture.
- ➢ Early-stage prediction scenarios will be made possible by the processing of hyperspectral pictures and meteorological data using artificial intelligence (AI) and machine learning techniques.

Conclusion

Designer crops are the crops that are designed by the breeder through genetic manipulation of crop over native genotype of plant using advance techniques of molecular biology. As we all know that 21st century agriculture is continuously struggling enormous challenges, it can be due to the growing population of the country by 10 billion in coming 2050. Increasing crop output will undoubtedly be necessary to feed this expanding population. Utilizing new genome editing technologies, which are a tool granted by nature and which breeders utilize very carefully to employ in plant breeding, is one viable approach to solve these issues. Considering that an organism's genes encode its unique characteristics.

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