Crop improvement through Marker Assisted Selection

Patel Savankumar N., Assistant Professor (GPB), School of Agriculture, P P Savani University, Surat - 394125.,

 Sakriya Shveta G., Assistant Professor (Horti.), School of Agriculture, P P Savani University, Surat - 394125.,

Amol Langhi, Junior Research Assistant, Agricultural Research Station, Savalivihir Farm, MPKV, Ahmednagar- 423109.,

Ketan S. Mungra, Assistant Research Scientist, Main Rice Research Center, Navsari Agriculture University, Navsari-396450.

**ABSTRACT**

The strong and effective method of marker-assisted selection (MAS) is used in crop improvement to speed up the breeding process and improve the selection of desirable traits. It is the method of choosing agriculturally significant features for crop development utilizing morphological, biochemical, or DNA markers as indirect selection criteria. Traditional breeding techniques are frequently labor- and time-intensive, and there is no assurance that the desired qualities will be obtained. But the development of molecular markers and advancements in genomics have completely changed field of plant breeding. Breeders can drastically cut the length of breeding cycles by locating and utilizing markers that are highly correlated with the trait of interest. In this study, we provide an overview of the benefits of MAS and its most extensively used applications in plant breeding, using different as examples. The big challenge for plant breeders in the coming decades will be to achieve a significant impact on crop improvement using MAS.

**Keywords**: Marker assisted selection, Crop improvement, Trait

1. **INTRODUCTION**

Marker-assisted selection (MAS) is a powerful and sophisticated approach used in crop improvement programmes to accelerate breeding and improve the efficiency of creating superior plant varieties. Traditional breeding procedures can be time-consuming and labor-intensive, necessitating numerous generations to acquire desired crop qualities. DNA marker technology, resulting from studies in molecular genetics and genomics, is one field of biotechnology that has considerable potential for plant breeding. Because of genetic linkage, DNA markers can be employed to detect allelic variation in the genes underlying these traits. The use of DNA markers to aid in plant breeding could considerably improve efficiency and precision. Marker-assisted selection (MAS) involves the use of DNA markers in plant breeding and is a component of the emerging discipline of "molecular breeding." (Collard *et al*., 2008). The basic purpose of crop improvement with MAS is to select plants with specified desirable molecular features. These properties could be connected to yield, disease resistance, stress tolerance, nutritional content, or any other economic or agronomic importance. Traditional breeding takes time and is highly dependent on environmental variables. It takes between eight and twelve years to breed a new variety, and even then, the introduction of an enhanced variety cannot be assured. As a result, breeders are very interested in emerging technologies that could improve the efficiency of this process. By utilising a variety of unique techniques to enhance selection strategies, molecular marker technology provides such a potential. (Akhtar *et al*. 2010).

1. **RESULTS AND DISCUSSION**

Marker-assisted selection has been used successfully in a variety of crops, including rice, maize, wheat, soybeans, and many more. Its combination with traditional breeding methods has resulted in the development of enhanced crop varieties that address modern agriculture's difficulties, such as climate change, pest and disease threats, and rising food security requirements.

The late-maturing high-yielding rice variety reeta from the donor parent, Swarna-Sub1, was introgressed with the quantitative trait loci (QTLs) Sub1 for submergence and Pup1 for low phosphorus stress tolerance as well as the narrow-grained trait GW5. The generated lines shared all morphoquality characteristics with the receiving parent, were better yielding, possessed submergence, and had low phosphorus stress-tolerance. Reeta-Panidhan (CR Dhan 413), a prospective pyramided line, has been released for the flood-prone areas of Odisha state using marker assisted breeding [4].

Using MAS giant embryos and golden-like traits combined in colored rice. It proves that for the biofortification purpose, the combination of molecular markers and traditional breeding method can be effectively used. PFR32 and RFR13 can become valuable products and adapt to the current agricultural community [5].

Widespread yield losses from tomato bacterial, fungal, and viral illnesses are to blame, particularly in humid growing settings. The uncommon recombination events that joined these resistance loci into a connected cassette that can be inherited collectively in subsequent crosses were sought after using marker-assisted selection. A novel connection of Xv3/Rx4 and Ty-2 was discovered using a pedigree breeding technique and marker-assisted selection. The results of this study indicate that the trait markers on chromosome 11 are useful for choosing plants that are resistant to the target illnesses because they are closely related to the corresponding resistance loci [2].

 The use of markers in selection (MAS) enables breeding to be completed more quickly while using fewer resources. The major fiber quality traits, such as fiber strength, fiber length, fiber uniformity, and micronaire, can be improved by utilizing novel QTLs and SSR markers. The first generation of MAS-derived cotton cultivars in Uzbekistan are the new cultivars "Ravnaq-1/Ravnaq-2," which were registered with the State Variety Testing Commission of Uzbekistan in 2014–2017. These findings demonstrate the potential of MAS in cotton breeding by demonstrating how the LD-block of chromosome 7 and its mapped molecular marker(s) and donor genotypes effectively assisted in the accurate and quick transfer of higher fiber quality QTLs to the commercially cultivated Upland cotton cultivars [6].

1. **CONCLUSION**

It is crucial that plant breeding keep up its impressive advances in crop development. It appears that contemporary breeding projects are continuing to advance through the use of conventional breeding techniques. Although there hasn't been much of an impact on variety development thus far, MAS could help plant breeders immensely in achieving this goal. Greater breeding programme integration, a thorough understanding of the current obstacles, and the creation of practical solutions are necessary for the potential of MAS to be realised. Utilising the benefits of MAS above traditional breeding could significantly influence fight against biotic and abiotic stresses along with yield and quality improvements. In the near future, the high cost of MAS will remain a significant barrier to its implementation for some crop species and plant breeding in developing nations. To suit particular crops, characteristics, and financial constraints, customised MAS techniques may need to be developed. The price of MAS may be significantly reduced with new marker technology. If the new techniques' efficacy is confirmed and the necessary equipment is easily accessible, MAS should be more broadly useful for crop improvement.

## REFERENCES

1. B.C. Collard and D.J. Mackill “Marker-assisted selection: an approach for precision plant breeding in the twenty-first century.” Philosophical Transactions of the Royal Society B: Biological Sciences. 2008, 363(1491), 557-572.
2. C.J. Orchard, J. Kressin, S. Chompookam, J. Chuapong, N. Onmanee, K. Van Leeuwen and D.M. Francis. “Marker-assisted Selection to Combine Alleles for Four Disease Resistance Genes of Tomato Collocated on Chromosome 11.” HortScience, 2023, 58(5), 495-501.
3. S. Akhtar, M.A. Bhat,, S.A. Wani, K.A. Bhat, S. Chalkoo, M.R. Mir, and S.A. Wani “Marker assisted selection in rice. Journal of Phytology” 2010, 2(10).
4. S.R. Barik, A. Moharana, E. Pandit, A. Behera, A. Mishra, S.P. Mohanty and S.K. Pradhan. “Transfer of Stress Resilient QTLs and Panicle Traits into the Rice Variety, Reeta through Classical and Marker-Assisted Breeding Approaches.” International Journal of Molecular Sciences. 2023, 24(13), 10708.
5. Y.P. Wu, Y.C. Chang, H.I. Kuo, B.N. Lin, S.M. Wang, and Y.C. Tseng. “The development of two high-yield and high-quality functional rice cultivars using marker-assisted selection and conventional breeding methods.” International Journal of Molecular Sciences. 2022, 23(9), 4678.
6. M.M. Darmanov, A.K. Makamov, M.S. Ayubov, N.N. Khusenov, Z.T. Buriev, S.E. Shermatov, ... and I.Y. Abdurakhmonov, (2022). “Development of superior fibre quality upland cotton cultivar series ‘Ravnaq’using marker-assisted selection.” Frontiers in Plant Science, 13, 906472.