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Use of Rootstocks in Fruit Crop Improvement

Tikam Das Vaishnav[1], Sohin Hashmi[2], Shruti[2]

[1]Assistant Professor, RNT College of Agriculture, Kapasan (Dist.-Chittorgarh), MPUAT – Udaipur
[2]M.Sc. (Hort.) Scholar, Dept. of Horticulture, Naini Agriculture Institute, SHUATS, Prayagraj (U.P.)

*Corresponding Author
Tikam Das Vaishnav*

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INTRODUCTION

The rootstock is the lower portion of a grafted plant that provides the root system for the scion. The rootstock not only supports the scion physically but also influences its growth, yield, and adaptability to environmental conditions. Rootstocks are indispensable tools for overcoming soil problems, managing tree size, and improving tolerance to abiotic and biotic stresses. In horticultural crops, rootstocks are used to impart specific desirable traits such as dwarfing, disease resistance, and stress tolerance.

Roles of Rootstocks in Fruit Crop Improvement

1. Control of Tree Size and Vigor

Dwarfing and semi-dwarfing rootstocks help regulate canopy size, allowing high-density planting and easy management. For example, in apple, rootstocks such as *M9* and *M26* reduce tree height and promote early bearing.

2. Influence on Yield and Fruit Quality

Rootstocks can improve fruit set, size, flavour, and sugar content. In citrus, *Cleopatra mandarin* and *Carrizo citrange* enhance juice quality and yield.

3. Tolerance to Biotic Stresses

Rootstocks offer resistance to soil-borne pathogens such as *Phytophthora*, nematodes, and wilt diseases. For example, *Dog Ridge* in grapes is nematode-resistant and improves survival in infested soils.

4. Tolerance to Abiotic Stresses

Rootstocks confer tolerance to salinity, drought, and temperature extremes. In mango, *Olour* and *Vellaikolamban* enhance drought and salinity tolerance.

5. Influence on Soil and Nutrient Uptake

Rootstocks affect water and nutrient absorption efficiency. Efficient root systems help in better nutrient uptake, enhanced photosynthesis, and improved fruit quality.

Rootstocks in Major Fruit Crops

Mango (*Mangifera indica* L.)

- **Common rootstocks:** *Olour*, *Vellaikolamban*, *Bappakai*
- **Functions:** Impart drought and salinity tolerance, influence canopy size, and improve survival under stress. Research shows that *Olour* rootstock improves water-use efficiency and provides resistance to saline conditions.

Citrus (*Citrus* spp.)

- **Common rootstocks:** *Trifoliate orange*, *Carrizo citrange*, *Cleopatra mandarin*
- **Functions:** Provide tolerance to tristeza virus, nematodes, and *Phytophthora* root rot. *Citrus rootstocks* also influence juice acidity, soluble solids, and overall fruit quality.

Apple (*Malus domestica* Borkh.)

- **Common rootstocks:** *M9*, *MM106*, *M26*
- **Functions:** Dwarfing, high-density planting, early fruiting, and ease of harvesting. Rootstocks like *M9* enable compact orchard design and uniform fruit quality.

Grape (*Vitis* spp.)

- **Common rootstocks:** *110R*, *99R*, *Dog Ridge*
- **Functions:** Tolerance to drought and salinity, nematode resistance, and influence on berry size and composition. Research demonstrates that *Dog Ridge* increases survival under saline conditions and enhances grape juice total soluble solids.

Guava (*Psidium guajava* L.)

- **Common rootstocks:** *P. molle*, *P. cattleianum*
- **Functions:** Resistance to wilt and adaptability to poor soil conditions. Rootstocks have been successfully used to reduce guava wilt incidence in infested soils.

Recent Advances in Rootstock Research

Recent advancements include molecular marker-assisted selection, genomic mapping, and biotechnology for developing stress-tolerant rootstocks. Interstocks and tissue culture propagation methods have been explored for better graft compatibility and uniformity. Molecular studies have identified genes related to drought, salinity, and disease resistance, facilitating targeted breeding programs.

The use of genomic tools, transcriptomics, and rootstock breeding has revolutionized rootstock development, providing opportunities to breed rootstocks specifically suited for climatic challenges.

Challenges and Future Prospects

Despite significant advancements, challenges such as graft incompatibility, limited rootstock diversity, and propagation constraints persist. Many commercial fruit crops rely on a narrow genetic base for rootstocks, increasing vulnerability to pests and diseases.

Future research should focus on:

- Development of **climate-resilient rootstocks**
- Understanding **rootstock–microbiome interactions**
- Use of **CRISPR and genomic selection tools** for breeding
- Enhancing **nursery production and certification** systems Integration of biotechnology, molecular genetics, and physiology will accelerate the development of rootstocks that ensure sustainability in fruit production.

CONCLUSION

Rootstocks play a crucial role in fruit crop improvement, offering solutions to manage tree size, enhance stress tolerance, and increase productivity. The use of suitable rootstocks has led to the success of modern horticultural systems, particularly under changing climatic and soil conditions.

With the integration of advanced breeding technologies and improved understanding of rootstock-scion interactions, the development of superior rootstocks will ensure sustainable fruit production and long-term orchard health.

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