IMPACT: International Journal of Research in Applied, Natural and Social Sciences (IMPACT: IJRANSS)
ISSN(P): 2347-4580; ISSN(E): 2321-8851
Vol. 5, Issue 5, May 2017, 27-32

ROOTSTOCK BREEDING FOR FRUIT TREE CROPS

RUPAL DHOOT[1], MEENAKSHI DHOOT[2] & VARUN KUMAR BADAYA[3]

[1]Department of Genetics and Plant Breeding, Anand Agricultural University, Anand, Gujarat, India

[2,3] Department of Plant Breeding and Genetics, Maharana Pratap University of Agriculture and Technology, Udaipur, Rajasthan, India

ABSTRACT

The rootstock influences tree size, productivity, fruit quality, pest resistance, stress tolerance, and ultimately profitability. It also reduces juvenility and tree vigor; bring a much improved degree of uniformity and consistency to an orchard. Therefore rootstock is very vital component of a grafted tree and determines the success or failure of a commercial orchard. Rootstock selection offers a powerful tool for the sustainable intensification of fruit production because while the scion genotype can be used to select fruit properties, adaptation to water deficit and high salinity, tolerance to alkaline soils and susceptibility to pathogens (e.g. Fire blight in apple) can be influenced by the choice of rootstock.

KEYWORDS: Rootstocks, Mango, Citrus, Guava and Apple

INTRODUCTION

Most of the fruit plants are propagated on a rootstock. Scion and stock grow together, although genetically different, but functioning infusion. Rootstock provides the root system, which anchor the tree and acts as an absorbing organ of water and mineral nutrients. Rootstock influences the tree size, precocity in bearing and resistance to biotic and abiotic stresses.

Drawbacks of Own Rooted Trees of Scion Cultivars

- Much vigorous than desired for modern production systems with delayed bearing.
- Lack their tolerance to soil borne pests and diseases.
- Non-uniformity in growth, tree size, efficient canopy, precocity, yield efficiency, adaptability to various biotic and abiotic stresses.

Therefore rootstock is very vital component of a grafted tree and determines the success or failure of a commercial orchard.

Aims of Rootstocks Breeding

- To create rootstocks resistant or tolerant to pests and diseases.
- To increase the adaptability to different soil and environmental conditions.
- To impart to the scion high yield, superior fruit quality and size and other essential traits.
- Successful rootstock should produce a large number of seeds, where possible, nuclear to facilitate large scale multiplication.

- Should show least differential effect on its desirable traits when grafted with different genotype scions.
- For dwarfism, makes suits for high density planting.
- For precocity in bearing

Importance of Rootstocks in Fruit Crops

- The choice of rootstock is very important as it determines the suitability of the tree for the position and the form in which one intend to grow it.
- As part of the tree, the rootstock influences many factors in addition to tree size, particularly productivity, fruit quality, pest resistance, stress tolerance, and ultimately profitability.
- A rootstock primarily provides a reduction in juvenility and tree vigor, thus, trees propagated with a rootstock combined with a pathogen-free scion bring a much improved degree of uniformity and consistency to an orchard.
- Rootstocks have also many characteristics that contribute in positive ways to the performance of a fruit tree.
- Further, the rootstocks influence various horticultural traits and provide tolerance to pests and diseases and certain soil and site conditions that contribute significantly to orchard profitability.
- A successful rootstock should have compatibility with the scion cultivar onto it.
- Rootstocks provide growers with useful tools to manipulate the vigor and production of orchard trees.
- Effects on tree size, fruit quality, precocity, fruit production and maturity are achieved through complex interrelationships between roots and canopy of the plants.
- Rootstocks directly affect the ability of plants to take up water and nutrients and significantly alter the pattern of canopy development and photosynthesis
- **Breeding approaches for rootstock improvement**
- **Conventional Methods**
    - Introduction,
    - Selection,
    - Hybridization
    - Intra-specific hybridization,
    - Interspecific hybridization,
    - Intergeneric hybridization

- **Non-Conventional Methods**
    - Somaclonal variation,
    - Somatic hybridization,
    - Transgenic breeding

CASE STUDIES

Mango

Dayal*et al.* (2014) studied the effect of rootstocks on growth, yield and physiology of mango cultivars. Rootstock K-5 inhibited canopy volume (CV) of PusaArunima, Pusa Surya and Dushehari, while Olour had an inhibitory effect on CV of Amrapali and Mallika. Kurakkan rootstock promoted highest yield in Amrapali and Pusa Surya, while both Kurakkan and Olour for PusaArunima; and K-5 and Kurakkan for Mallika seem to be more productive.

Pandey*et al*. (2014) observed effect of salinity stress on growth and nutrient uptake in polyembryonic mango rootstocks. Based on overall performance and leaf scorching, it could be said that salinity tolerance increased in the following order Chandrakaran<Moovandan<Bappakai<Nekkare<Kurukkan<Terpentine<Olour rootstocks.

Citrus

Anjum*et al*. (2001) evaluated citrus rootstocks *i.e.* Jattikhatti (*Citrus jambhiri*), Jambherikhatti (*C. jambhiri*), Gadadehi (*C. aurantium*), Kharnakhatta (*C. Karma*), Cleopatra mandarin (*C. reshni*) and Yuma citrange (*Poncirustrifoliata x C. sinensis*) were evaluated for salinity tolerance. Results suggested that Cleopatra mandarin and Gadadehi proved to be the most tolerant, while Kharnakhatta was the least tolerant one and Jattikhatti, Jambherikhatti and Yuma citrange were moderately salt tolerant.

Fagoaga*et al*. (2007) reported that the architecture of citrus plants can be modified by genetic manipulation of endogenous *GA20oxl* gene expression in transgenic plants. By down-regulating *GA20oxl* gene we can reduce the scion plant stature.

Aboutalebi*et al*. (2012) evaluated the effect of four citrus rootstocks (Sour orange, Bakraei, Mexican lime and Volkamer lemon) on valencia orange leaf chlorophyll content and mineral elements concentration (N, P, K, Ca, Na, Mg, Fe, Zn, Mn, Cl, Cu and B). Highest chlorophyll content was observed on sour orange rootstock. Rootstock types had a significant effect on leaf mineral concentrations except of Cl and Na. Lowest Na concentration observed in leaf scion on Volkamer lemon rootstock. Probably Volkamer lemon rootstock had a little trend to accumulation Na in leaf scion than other rootstocks.

Singh (2016) developed citrus rootstocks through hybridization between rough lemon and trifoliate orange, Troyer citrange. Rough lemon is the most commonly used rootstock for Nagpur mandarin. For a rootstock to be successful, it should have faster growth in the nursery and the hybrids 2.6 (rough lemon x Troyer citrange) and 3.1 (rough lemon x trifoliate orange) were vigorously growing in the nursery. Further, the hybrids 2.6 and 3.1 are similar to rough lemon in all aspects and have very few trifoliate leaves (0.01 %).

Guava

Gill and Chahil (2009) observed the Sardar cultivar on Portugal rootstock produced healthy trees and totally free from bark splitting. While Allahabad Safeda cultivar produced healthy trees and totally free from bark splitting in Portugal, AnnuIshakwala and Mirjapur seedling rootstock. They also reported that Sardar cultivar on Portugal rootstock registered fruit yield per tree as compared to other rootstocks.

Apple

Modgil*et al.* (2012) identified somaclonal variants of the apple rootstock Malling7 resistant to white root rot caused by *Dematophoranecatrix.* 70% fungal culture filtrate derived from *D. necatrix* was found to be suitable for in vitro screening of cells rootstocks in fruits.

CONCLUSIONS

- No single rootstock is widely adapted to a wide range of conditions in improved crops.
- Rootstock influence many characters of scion like tree size, canopy volume, no. of leaves per plant, leaves an area, protein and phenol contents, pest & disease resistance and stress tolerance.
- Superior productivity, precocity and vigor control are very important for orchards which is influenced by the rootstock.
- New rootstock cultivars, with added pest resistance, increased hardiness and better anchorage are urgently needed in apple and guava.
- GM rootstock reduces tree size in citrus.
- Novel rootstock has been developed through somaclonal variation in apple.
- There is an urgent need to develop improved rootstocks in various fruit crops for specific requirement through conventional and non-conventional breeding approach.

FUTURE THRUSTS

- Development of complex hybrids through interspecific, intraspecific and intergeneric hybridization to develop more versatile rootstocks to increase their usefulness and adaptation with respect to compatibility, size control, precocity, productivity and resistance to biotic and abiotic stresses.
- Survey, selection and evaluation of a large number of indigenous fruit species to explore their possibilities to use as rootstocks under different agro-climatic conditions.
- Development of virus free material for commercial rootstocks to reduce virus-related incompatibility problems and to maintain sustainability in productivity and fruit quality.
- Development and use of efficient interstocks, which are still lacking in several fruit crops to eliminate compatibility problems.
- Need to develop rootstocks for dwarfism.
- Use of biotechnological tools for the development of rootstocks for biotic and abiotic stress tolerance.

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