

Recent Advances In Root Stock Management in Sub-Tropical and Temperate Fruit Crops

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ABSTRACT: Rootstocks are very important in identifying orchard production in fruit crops. The combining different two parts of a plant by grafting, budding, layering or any other propagation can bring new or different types of plant growths effect. The outcome or result of rootstock in temperate fruit crops compared to tropical and subtropical fruit crops is well illustrated on fruit quality in the case of physical and chemical compositions. This difference can be described by matching the relative importance of rootstocks for precocity, yielding, tree size control, and through contrasts in annual phenological cycles, fruit respiration attribute, crop density and canopy management techniques. But these effects on functional, chemical and molecular fronts are still not understood.

Key words: Recent advances, root stock, temperate and sub-tropical fruit crops

INTRODUCTION: A rootstock is nothing but it is a plant part, usually under the ground and from which above ground part is growing. It also illustrates that a stem which has a well developed root system. The plant part grafted onto the rootstock is usually called the scion. The rootstock is the lower part of the grafted plant, which produces its roots. “Under stock” and “stock” meaning is the same with “rootstock” and scion is the grafted part of the plant that builds the plant branches and shoots. In the future it will convert to leaves, branches, stems, flowers and fruits.

Rootstocks is essential

(1) Hazards of the physical environment: Soil problems in poor internal drainage, drought, pH too high or too low (= lime chlorosis or Al and Mn toxicity) and insufficient in essential elements; low temperatures and high temperatures.

(2) Hazards of the vital environment: Bacteria, fungus, nematodes, arthropods, viruses and viroid's, mycoplasmas and Spiro plasmas and rodents.

(3) Horticultural problems in orchard: Tree size control, poor anchorage, excessive suckering, burr-knots, lack of precocity, low production efficiency, smaller fruit size, diminished fruit quality, and delayed incompatibility.

(4) Horticultural problems in nursery: Difficult propagability, bud-break too early, fall maturity too late, limited period for budding, and poor compatibility.

Types of rootstock

1. Seedling rootstock: These rootstock develop from the germinated seeds.

2. Clonal rootstocks: Rootstocks, which are propagated asexually are called clonal rootstocks.

Stock-scion relationship: A budded or grafted tree may produce abnormal growth characters that may be different from which would have occurred, if each constituent part of a graftage viz., stock and scion was grown individually or when it is grafted or budded in other types of stocks. Several of these have major horticultural worth. This different feature of stock may impact the performance of a scion cultivar which is known as stock-scion relationship. The stock and scion or vice versa interactions are known to alter the size, growth, productivity, quality and other attributes of different stock scion in horticultural crops.

Different stock scion relationships are divided into three types:

- A) Effect of stock on scion
- B) Impact of scion on stock
- C) Impact of inter-stock either on stock, scion or both.

A) Effect of stock on scion

1) On size and growth:

- ✓ According to the effect of stock on scion apple can be classified as dwarf, semi dwarf, vigorous and high vigorous stocks.
- ✓ If a scion grafted on dwarf stocks, the scion will grow less vigorously, but if the same scion grafted on very vigorous stocks or rootstocks, the scion will grow very vigorously.
- ✓ Trifoliolate orange is considered as dwarfing stocks for grape and sweet oranges.
- ✓ Some of mango rootstocks give dwarfness when grafted on scion cultivars like Kalapade, Olour and etc.
- ✓ If guava cultivars grafted on *Psidium pumilum* it will be dwarf in size. Pusa Srijan guave stock, also give dwarfness in Allahabad Safeda, and it is a commercial cultivar of guava.

2. Precocity in flowering and fruiting:

- ✓ The time taken from planting to fruiting is called precocity and it is effected by rootstocks. Generally precocity is related to dwarfing stocks or rootstocks and slowness to fruiting with vigorous stocks.
- ✓ Mandarin citrus fruit, when grafted on *Citrus jambhiri* rootstock is taken less days for fruiting than those grafted on acid lime or stocks.

3. Fruit set and yield

- ✓ The stocks are directly effect on the production of flower, fruit set and fruit yield in oriental Persimmon (*Diospyros kaki* cv. Hachiya). When it is grafted on *D. lotus*, it will produces plenty of flowers but only few flowers will mature into fruits. Whereas, when *D. kaki* is used as the rootstock, the fruit set percentage will be very high.
- ✓ When acid limes budded on rough lemon it will increased 70 % of yield compare to those budded on troyercitrange, Rangpur lime or its own stock.

4. Fruit quality

- ✓ When Sathugudi sweet oranges grafted on Gajanimma rootstocks it bears large but poor quality fruits while on its own stocks, they impart fruits with numerous quality and juice content.
- ✓ The physiological disturbance like 'granulation' in sweet orange is very low if grafted on Cleopatra mandarin seedlings, whereas, rough lemon seedling stocks stimulate high granulation.
- ✓ If *Pyrus communis* used as a stock in Bartlett pear the physiological disturbance of black end will not occur, but when *Pyrus pyrifolia* used as a stock than black end will appeared and affecting the quality of fruits.

5. Nutrient status of scion

- ✓ Rootstocks also affecting the nutrient behavior of scion. When Sathugudi orange trees budded on *C. volkarimariana* root stock it gives better nutrient status of all nutrients in the leaves than on its own rootstock or Cleopatra mandarin rootstocks.

6. Disease resistance

- ✓ In citrus, an appropriate variation exists between the rootstocks in their return to diseases and nematodes. For example rough lemon stock is tolerant to tristeza, xyloporosis and exocortis but is responsible to gummosis and nematodes. However, troyer citrange is tolerant to gummosis but responsible to exocortis virus disease. Similarly, grafting of guava varieties on Chinese guava (*Psidium frie-drichsthalianum*) tolerant against wilt diseases and nematodes.

7. Winter hardiness

- ✓ Grafting of Young grapefruit trees on Rangpur lime succeed on winter injury better than on rough lemon or sour orange. Sweet oranges and mandarins on trifoliolate stocks were colder and hardy.

8. Capability to stand out the soil opposing status

- ✓ Foliate orange shows weak ability on citrus rootstocks, whereas, Rangpur limes, Sweet orange and Sour orange stocks shows medium capability to stand out against more salts in the soil condition. Similarly, in pome fruit, alteration stand between rootstocks to stand out surplus soil moisture or surplus B in the soil structure. Myrobalan rootstocks of plum commonly tolerate

surplus B and wet situation than Marianna plum root or other rootstocks' viz., peach, apricot or almond.

B) Effect of scion on rootstock

1. Vigor of the stock

- ✓ Scion cultivar effect on size, nature and form of the stock. When we grafted a vigorous scion on weak or dwarf stocks, than the growth of the stocks also induced, but if weak or dwarf scion grafted on vigorous stocks, the growth of the stocks will be decrease.
- ✓ A strong scion always cause the roots to become more resistant to wet, poorly aerated soils.
- ✓ It is reported that if apple seedling budded on Red Astrachan apple the stock produced very fibrous roots system, whereas, the scion 'Goldenburg' was budded on the same seedlings, produce two or three prolonged deep-rooted system without fibrous root system.

C) Influence on inter-stock

- ✓ To use certain dwarfing rootstocks as a vigorous for producing a non-vigorous and early bearing trees is in practice.
- ✓ Paradise apple is largely used as inter-stock among scion cultivar and crab apple stock, for reducing precocity in bearing.
- ✓ Similarly, use of Malling IX dwarfing stock as rootstock is a viable technology in businesswise.
- ✓ For Amrapali, Anupam variety of mango is recommended as inter-stock, grafted on Mallika stock to stimulate dwarfness, precocity and development in fruit quality. On the other hand, sometimes inter-stock might not effect on desirable characters.

Future importance of the study

Recent advances in rootstocks management play a crucial role in determining orchard efficiency and sustainability in fruit crops. Rootstocks can influence precocity/ juvenility, yield, tree size control, disease resistance or tolerance, fruit respiratory behavior, crop load and canopy management techniques.

Review of literature

Apple

Mohammad *et al.* (2016) reported that the 'Golabkohanz' on the MM 106 rootstock had the maximum shoot length (39.97 cm) and maximum tree height (198.33 cm). Whereas, 'Golab-kohanz' (6.40 cm), (33.58 cm²) and MM106 rootstock (7.39 cm), (33.09 cm²) had the highest trunk diameter and trunk cross sectional area respectively. The highest internode length of the current year belonged to

MM106 rootstock (5.12 cm). ‘Delbarstival’ (141 cm) and M9 Rootstock (133 cm) had the maximum canopy width tree. Then, ‘Delbarstival’ on M₉ rootstock had the highest yields of trees (14.61 kg tree⁻¹), yield in hectare (40.56 ton ha⁻¹) and yield efficiency (519.33 kg cm²).

Nadia *et al.* (2019) reported that one year old two cultivars of apple were grown in a green house, Honeycrisp and Gala together with four stocks *viz.*, G890, G41, M9 and B9. Below ground abiotic environmental treatments were imposed for 60 days after trees reached approximately 45 cm height. The scarcity of water decreased above ground biomass and to a lesser extent, root biomass. ‘Gala’ and the stock G890 indicate high mineral nutrients uptake considered to ‘Honeycrisp’ and the other rootstock. In addition, G890 displayed greater plasticity for both biomass and mineral nutrient supply. High soil temperatures increased the ratios of K : Ca, N : Ca, Mg : Ca and (N + K + Mg) : Ca in leaf tissue of stock G41 and ‘Honeycrisp’.

Pear

Tamura (2012) studied that *P. betulaefolia* (J.Pear) shows excellent compatibility to various environmental conditions, with maximum endurance to drought, cold, and salt. This is due to *P. betulaefolia*'s high ability to control osmotic potential and ability to sustain a maximum degree of unsaturation in fatty acid in biological membranes during cold hardening. *P. calleryana* is not only a high drought tolerance, but also the highest flood tolerance. This tolerance depends on the ability of *P. calleryana* to convert to alcohol fermentation under anaerobic condition and to bring out the ethanol thus generated. These two rootstocks are highly efficient in prohibiting fruit hardening disorders. Whereas, *P. betulaefolia* shows maximum salt tolerance between native Asian *Pyrus* species, it is transgress in this respect by two native Mediterranean species, *P. amygdaliformis* and *P. elaeagrifolia*, with a mechanism to prohibit the transport of salts from the roots to above ground plant parts.

Cherry

Monica *et al.* (2017) reported that the lengthy shoots, in mean values, gave the different with cultivars grafted on Mahaleb stock (111.7 cm). ‘Gisela 5’ rootstock reduces the average length of annual growth (93.3 cm). Trees grafted on Mahaleb formed additional lengthy fruiting shoots and few small fruiting shoots than those grafted on ‘Gisela 5’. The highest average trunks cross sectional area were received for the cultivar grafted on Mahaleb (62.1 cm²).

Peach

Legua *et al.* (2012) studied the influence of eight Prunus rootstocks (GF-677, Krymsk® 86, PADAC 97 - 36, PADAC 99 - 05, PADAC 9912 - 03, PADAC 0024 - 01, PAC 0021 - 01 and PAC 0022 - 01) on vigorous, yield and quality fruit traits of “UFO 3” flat peach cultivar was studied. The maximum trunk cross sectional area was depicted by GF-677 and the minimum by PADAC 99-05. The maximum yield performance was found on PADAC 99 - 05, PAC 0021 - 01, PAC 0022 - 01 and PADAC 0024 - 01 and the minimum was observed on Krymsk® 86. “UFO 3” grafted on GF-677 showed in the highest fruit weight, whereas, the minimum was on PADAC 99 - 05. Fruits of “UFO 3” exhibited a tendency to have maximum firmness, highest red colored skin and RI (ripening index) when grafted on PADAC 99 - 05.

Persimmon

Yakushiji *et al.* (2008) observed that persimmon grafted on *D. rhombifolia* stock were the almost all dwarfed, however, their total shoots length and number of shoots per tree were very less. The height and canopy volume of trees on No. 3 were almost 78% and 50%, respectively, compare to control. Trees on S22 revealed alike semi-dwarfing result. All trees canopy volumes were favorably and directly related to the total shoots length, number of shoots, and trunk cross sectional area of the scion.

Grape

Satisha *et al.* (2010) reported that Thompson Seedless variety grafted on Dog Ridge give rise to the maximum yield and well quality fruit. Over the years we might observe bumpy bud sprouting, gaps on the cordon because of dead wood formation, and decreased yield in vines, grafted on Dog Ridge tstocks. In difference, Thompson Seedless variety grafted on 110R carried out good in terms of moderate vigor, enhanced fruitfulness and consistently maximum yield. Dog Ridge and St. George produced a lowest yield, owing to enhanced vigor measured in terms of total shoot, pruning weight and cane diameter. Rootstocks 110 R, 1103 P and 99 R are also well known to enhanced water use efficiency during crucial growth stages of fruit bud separation and full bloom.

Conclusion

The stock is the lower part of the grafted plant, the part which produces its roots. Rootstocks and under stocks are synonyms for stocks.

Scion is the part of the grafted plant that produce the plant’s branches and shoots. It gives leaves, stems, branches, flowers and fruits in the future.

The result of stocks and inter stocks pertaining to growth, flowering, and fruit set, yield performance and quality characters of fruit crops are difficult and imperfectly understood. Studies on understanding the mechanisms underlying these effects would assist for future stock breeding and selection. A better knowing of endogenous growth material, stock-scion interactions, soil or climatic factors required to be studied, which would help more useful selection and use of rootstocks in the future. There is an emergency need to develop rootstocks tolerant to biotic and abiotic stresses in various tropical, sub-tropical and temperate fruit crops.

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