CHAPTER 5

ROOTSTOCKS FOR FRUIT CROPS, THEIR PROPAGATION AND USES

OBJECTIVES

After reading this chapter, you will be able to know:

- About rootstock and its importance in fruit industry
- Characteristics of an ideal rootstock
- Favourable influences of rootstock on scion cultivar
- Different rootstocks being used commercially in fruit industry

INTRODUCTION

In class XIth and in previous chapters, you have read about propagation of horticultural crops. Most of the fruits are propagated by vegetative methods rather than seeds. Some fruits respond better to budding and grafting techniques of propagation rather than to cutting, or layering. For raising fruit plants through budding or grafting, we need another plant (rootstock) on which scion of desired variety is raised. Budded and grafted plants are called as 'composite plants', as they have two parts, one which grows in soil (rootstock) and another, which is a desirable variety or cultivar (scion), which later bears fruits. Thus, rootstock provides anchorage to the composite plant. You might have gone to a

Points to remember

- Rootstocks are divided in to two groups: seedling and clonal.
- Seedling rootstocks in general provide better anchorage than clonal rootstocks, yet their use is limited as they are not genetically uniform.
- Clonal rootstocks are propagated through vegetative means and impart favourable influences on scion.

fruit plant nursery and might have seen some plants having joints. So the plant part below joint is rootstock and above the joint is scion. In this chapter, you will come to know about the importance of rootstock, characteristics of an ideal rootstock and favourable influences, which a rootstock can exert on scion cultivar.

Classification of rootstocks on basis of propagation

Rootstocks can be divided into two groups viz. seedling and clonal rootstocks on the basis of their method of propagation.

Seeding rootstocks

These rootstocks develop from the germinated seeds and have some advantages like, it is relatively simple and economical to raise them through seeds. Such rootstocks are usually well adapted to mass propagation. Moreover in some cases, the root system tends to grow deeper and to be more firmly anchored than the vegetatively propagated rootstocks as experienced in case of plum rootstocks. Most of the seedling plants do not retain viruses dwelling in parent plants although some exceptions are there like that of citrus.



Raising citrus rootstocks

Seedling rootstocks have certain drawbacks, like genetic variation, which results in un-uniform growth and performance of scion cultivar (s) of the grafted or budded plants. Seedling rootstocks are commonly used in mango, *ber*, pecan nut, pistachio nut etc.

Clonal rootstocks

These rootstocks are those, which are multiplied through vegetative means either by stooling, layering, rooted cuttings or by aseptic tissue culture method. Individual rootstock plant so raised has the same genetic make-up, which in turn result in uniform growth and performance of scion of grafted plants. In polyembryonic species like citrus, seedlings of nucellar origin are clonal and to great extent uniform in growth. The clonal rootstocks are more popular in fruit crops, like apple, pear, plum, cherry, grape and citrus.



A view of raising guava rootstocks by stooling



Different stages of micropropagation of grape rootstock

History of the rootstock use

The use of rootstock in fruit production can be traced back to ancient times. There are evidences that the use of rootstocks was known to the Chinese as early as 1560 BC. Like wise, in Europe, during the days to Roman Empire, the use of olive rootstocks was very popular. The use of Phytophthora resistant rootstocks in citrus industry in Azones started in 1842. However, the development of Malling series of rootstock in apple brought revolution in the history rootstock uses. Since then, many rootstocks have been developed and used in fruit industry for various desirable effects on scion.

Characteristics of an ideal rootstock

An ideal rootstock should fulfill the following criteria:

- It should be easy to propagate either vegetatively or by seeds.
- It must have good root system, which will provide adequate anchorage to support the tree grafted on it without staking.
- It must produce a good, clean, upright stem, easy to budding or grafting.
- It should have wider soil and climatic adaptation. •
- It should have better congeniality/compatibility with the scion cultivar(s) or interstock.
- It should impart favorable influences to the scion cultivar.



A view of size control in apple with different rootstocks

Points to remember

- Development of Malling series of rootstocks at East Malling Station, England revolutionized the apple industry in Europe.
- These rootstocks were susceptible to woolly apple aphid, and then MM series rootstocks were developed by closing M series with Northen Spy.
- M-series rootstocks were not successful in India due to poor fertility status of Indian soils, bad suckering habit and rainfed conditions. However, MM series rootstocks were successful and have been used for HDP of apple in India.
- M₂₇ is the most dwarfing apple rootstock and Flying Dargon for citrus, used commercially for high density planting (HDP) throughout the world.

- It should have high degree of winter hardiness, tolerance to high salts, diseases and insect-pests etc.
- It should be easily available.
- It must induce dwarfing, precocity in bearing and heavy cropping effects to the scion cultivar.

Beneficial effects of rootstocks

The various effects of stock on the scion cultivar have been described briefly hereunder:

Tree vigour

Using rootstock, the vigour of scion cultivar can be controlled as per the grower's need. For example, on the basis of varying degree of effect on the vigour of scion cultivars, the apple rootstocks have been grouped in different categories like very dwarfing, dwarfing, semi-dwarfing vigourous and very vigourous.

Very dwarfing : M_{27} is the most dwarfing clonal sootstock. It was developed at East Malling Research Station, England in 1929 from a cross between M_9 and M_{13} .

Dwarfing: It is the most widely used dwarfing rootstock for apple. It had originated as chance seedling.

Semi dwarfing : M_{29} , M_{7} , MM-106.

Vigourous : MM-104, MM-109, MM-111.

Very vigorous : M_{16} , and M_{25} .

In mango, rootstocks like Taimuria, Olour, Rumani, Nekkare and Kurukkan have been classified as dwarfing rootstocks, while Dashehari, Chausa, Moovandan, and Sukar China as vigourous rootstocks. Vellai Kolumbam, Totapuri Red Small and Creeping have also been classified as dwarfing rootstocks. In citrus, Flying Dragon is the most dwarfing rootstocks, primarily used in high density planting systems in most part of the world.

Anchorage

The primary and most important function of rootstock is to provide anchorage to tree by growing deep into the soil. Rootstocks with deeper root system avoid the need of staking and hence reduce the cost of cultivation. The dwarfing apple rootstocks like M_{27} and M_{9} , usually require staking particularly in early years due to brittle nature of their roots. Hence, these rootstocks could not prove to be beneficial to apple industry in Himachal Pradesh (India) because apple is grown in rainfed conditions whereas these rootstocks perform well under irrigated conditions. Similarly, seedling plants owing to their deep root system are preferred as rootstocks in windy area.

Precocity in bearing

Dwarfing rootstocks bring precocity in bearing in fruit crops. Most striking example of induction of precocity in bearing has been the use of dwarfing rootstock (M_9 and M_{27}) in apple. In citrus, Sathgudi orange shows precocity in bearing when budded on Gajanima and acid lime rootstocks. Similarly, Kinnow plants come into bearing at an early date if budded on Troyer citrange, as compared to *Karna Khatta* and *Soh Sarkar* rootstocks. Flying Dragon, a world known citrus rootstock also induces precocity in bearing in the different scion cultivars.

Flowering, fruiting and yield

It is a well-known fact that flowering, fruiting and yield are chiefly governed by rootstocks employed in different fruits crops. In general, the yield per tree basis is less on dwarfing rootstocks but yield in terms of per unit tree volume is always very high. Moreover, due to dwarfing effect of rootstocks, accomodation of plants is 2 to 3 times higher than on the conventional rootstocks, which further adds to yield. Dwarfing rootstocks usually

help the scion cultivar to flower early and profusely than the vigorous rootstocks (e.g. apple rootstocks).

Fruit size and quality

Rootstocks have significant influence on fruit size, yield and quality. Dwarfing rootstocks, although induce precocity in bearing but fruits size is somewhat reduced. Vigorous rootstocks produce fruits of larger size. For example, small sized fruits are produced by dwarfing apple rootstocks (M_9 and M_{27}) than the seedling rootstocks. Further, Kinnow fruits on Troyer citrange are smaller in size than on *Karna Khatta* and *Soh Sarkar* rootstocks. In guava, the fruits of Allahabad Safeda are smaller in size but with better quality on Pusa Srijan than on its own roots.

Overcoming incompatibility

The problem of graft incompatibility is often encountered in various fruit crops, such as, pear, *ber*, walnut, cherry, citrus etc., leading to short orchard life. But in citrus and *ber*, the graft incompatibility has been used as a tool to dwarf the plant. *Ber*, when grafted on *Zizyphus nummularia* develops the symptom of inverted bottle neck disorder due to graft incompatibility. This disorder has been utilized for induction of dwarfing in *ber* for high density planting.

Diseases

Rootstocks are classified as susceptible or resistant according to their response to pathogen attack. The different relations of rootstocks to the various pathogens may be grouped into the following types *viz*. susceptible, tolerant, resistant and immune. For example, among 16 rootstocks tested for sweet orange, Sohmyndog, Jambhiri Kodur, Jambhiri Bombay and Rangpur lime were tolerant to tristeza viral disease and greening mycoplasmal disease but were susceptible to *Phytophthora* root rot. Similarly, Cleopathra mandarin is almost resistant to all viral diseases.

Abiotic stresses

Abiotic stresses like salinity and alkalinity, frost etc. cause havoc to the fruit crops and thereby effect the production and productivity invariably. Some rootstocks have special feature to fight against these abiotic stresses. For example, Kurukkan is highly suitable mango rootstock in salt affected soils as it can tolerate high salts effectively. Salt Creek and Dog Ridge have been classified as salt tolerant rootstocks for grape. Rangpur lime rootstock of citrus has wider soil adaptability. Trifoliate orange citrus rootstock can exclude the winter injuries effectively. *Citrus unshiu* is regarded as freeze tolerant rootstock of citrus. *Jatti khatti* strain of Rough lemon citrus rootstocks is suitable for saline and alkalive soils.

Insect-pests

On the basis of rootstock's response to insect-pest attack, these have been classified as susceptible, tolerant, resistant and immune. For example almond rootstocks like Almen, Almen 88 and Almen 201 are resistant to nematodes. Grape rootstocks like Dog Ridge and 1613 are resistant to phyloxera root louse.

A brief information about different rootstocks and their chief characteristics used in fruit industry has been given in the following table.

S.No.	Fruit crop	Fruit crop	Distinct influence on scion
1	Mango	Totapuri Red Small	Dwarfing
		Vellai Kollumban	Dwarfing
		Rumani, Olour	Dwarfing
		Kurukkan	Salt tolerance
		Creeping	Dwarfing

• Visit a fruit nlant nurserv in vour locality. Ask gardeper (mali) for budded and grafted fruit nlants. Make a

2	Grape	Dogridge	Resistance to <i>Phylloxera</i> , nematodes and salts.
		Salt Creek	Resistance to salt and nematodes
		St. George	Resistance to <i>Phylloxera</i> root louse
		Temple	Resistant against pierce's disease, anthracnose and downy mildew
3	Ber	Ziziphus nummularia	Dwarfing effect
4	Guava	Pusa Srijjan	Dwarfing effect on Allahabad Safeda scion cultivar
		Psidium pumilum	Dwarfing effect on Allahabad Safeda scion cultivar
5	Citrus	Flying Dragon	Most dwarfing, highly suitable for high density planting
		Trifoliate orange	Deciduous, cold hardy, dwarfing, resistant to nematodes, resistant to most viral diseases
		Cleopetra mandarin	Most salt tolerant citrus rootstock
		Rangpur lime	Resistant to tristeza, and exocortis
		Sweet orange	Hardy rootstock, adaptable to various soil conditions and salt tolerant
		Rough lemon	Relatively tolerant to saline and calcareous soils
		Sour orange	Cold hardy, resistant to phytophthora root rot but highly susceptible to tristeza
		Citrus unshiu	Freeze tolerant
6	Apple	M ₉	Dwarfing effect and highly suitable for high density planting
		M ₂₇	Ultra-dwarfing, suitable for high density planting
		Malus sikkimensis	Induces precocity in bearing
		M ₂₆	Better anchorage to scion cultivar
		M ₇	Semi-dwarfing, stronger and deeper root system
		Mm ₁₁₁ & MM ₁₀₆	Suitable for light sandy soils
		Northen Spy	Wooly aphid resistant
		MM-series	Wooly aphid resistant
		EMLA series	Free from viruses

7	Peach	Nemaguard	Resistant to nematode and crown gall
		GF-557	Nematode resistant
		GF-677	Drought tolerant, and high pH tolerant
8	Pear	Quince C	Semi-vigorous rootstock
9	Plum	Pixie and St. Julien	Dwarfing rootstocks
		Mariana 2624	Semi-resistant to nematodes, crown gall, cold hardy and tolerant to high soil moisture
		Myrobalan B	Resistant to bacterial gummosis
10	Almond	GF-557 and GF-677	Tolerant to high soil pH
		Alnem 1	Resistant to nematode





list of fruit plants and rootstocks.

• Plan a visit to some ICAR institute related to fruit crops. Visit their orchards. Make observation on the effect of rootstocks on different fruit plants.

CHECK YOUR PROGRESS

- 1. What is rootstock? Describe the importance of rootstock in fruit industry.
- 2. What characteristics an ideal rootstock should have? Discuss in brief.
- 3. Discuss briefly the positive influences of rootstock on scion cultivar.

FILL IN THE BLANKS

- 1. Seedling rootstocks provide better in the soil.
- 2. Clonal rootstocks are usually propagated through.....
- 3.is the most dwarfing rootstock of apple.
- 4.is the most dwarfing rootstock for citrus.
- 5.rootstock of grape is resistant to salts and nematodes.
- 6. Pusa Srijan is a rootstock of

SUGGESTED FURTHER READINGS

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