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ROOTSTOCK AND SCION RELATIONSHIP IN FRUIT CROPS

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Fruit crops are mainly propagated by vegetative means (cutting, budding, grating, layering etc.). Rootstock and scion are used to in budding and grating process, and they express different effect on each other when stock and scion are compatible to form a good union. The resultant of the good union gives a complete single plant. Rootstocks are used to propagate scions of preferred cultivars, improve fruit tree tolerance to environmental stress, and to control tree size. Size-controlling rootstocks are economically important for high-density plantings that may produce larger fruit and more fruit per hectare. Rootstocks affect the tree size and vigour, fruit set, yield and quality of the scion. Rootstock also imparts winter hardiness and tolerance/resistance to biotic and abiotic stress to the scion. Similarly, scion has also effect on rootstock. Rootstock–scion interactions demonstrated that rootstock had more influence than scion on tree weight and growth rate.

Controlled multiplication of plants is known as plant propagation. Plant propagation can be broadly classified in two categories: sexual and asexual. In sexual propagation, the fusion of male and female gametes (Zygote) gives rise to a new plant, whereas in asexual propagation (vegetative propagation) the development of new plants takes place without the fusion of male and female gametes, the new plant develops from vegetative plant parts. Various techniques of asexual propagation are adopted in plant propagation, such as: cutting, budding, grafting, layering, etc. In cutting and layering, only one plant (mother plant) is used and root develop on it whereas in budding and grafting, two plants are used. One which form root is known as rootstock and other form shoot are known as scion. After joining of both parts, they acted as a single plant and performed all the physiological and biochemical activities.

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Plant propagation is both a science and an art. The science of plant propagation requires knowledge of plant physiology, nursery cultural practices, and characteristics of the particular plant that we want to grow. The art of plant propagation can learn only through experience in the field. It requires specific technical skills that must be acquired through innate ability or experience and often requires a certain feel. The relationships of the scion with rootstock are very important to develop a single plant and for further flowering and fruiting. Stock and scion must be compatible to form a good union. Rootstocks have many advantages in fruit culture because it is resistant to many biotic and abiotic stresses, and have many beneficial effects on fruit yield and quality. A few studies on rootstock have been conducted in many fruit crops. Some rootstocks are available in mango, citrus, grape, sapota, apple and pear but in many fruit crops rootstocks are still searching. In litchi, some dwarf genotypes viz., GandakiYogita, NRCL-29 (Lal et al., 2019), NRCL-83, NRCL-86and NRCL-88 have been identified which can be used as rootstock to assess the effect on different parameters. Many traits associated with dwarfness in fruit plants. High bark wood ratio, small leaf, small fruit, close arrangement of leaf and higher percentage of bark area are important traits for dwarfness in litchi. The growth patterns of budded or grafted plant are different from those that would have occurred if each part had been grown separately (Hartmann *et al*., 2002). Some of these effects are very important in horticulture. These altered characteristics may result from:

(a) Some of the specific character of scion or rootstock not found in each other, e.g. resistant to certain diseases, insects or nematodes

(b) Interactions of rootstock and scion alter size, growth, yield, fruit quality

(c) Incompatibility reactions.

The rootstocks provide growers with a useful tool to manipulate the vigour and performance of orchard trees. Tree size, precocity, fruit production and maturity influences by scion and rootstock are resultant of complex interrelationships between roots and canopy of the plant. The capability of plants to take up water and nutrients from soil is directly affected by rootstock. They are also able to significantly alter canopy structure and photosynthesis in leaves.

Characteristics of good rootstocks

Once orchard is developed by heavy investment to use rootstock, changing in plantation causes serious losses (Rajput and Haribabu, 1995). Rootstock affects plant growth

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and development, tree life, adverse conditions (soil, disease, and climate), fruit quality, yield and so on. Rootstock should possess the following characteristics:

- It should be compatible with scion cultivars and give maximum productive life to the trees.
- It should be well adapted to the agro-climatic conditions of the particular locality like frost, cold and heat.
- It should be resistant to diseases and pests prevalent in the concerned area.
- It should be tolerant to adverse soil conditions like salt, alkalinity, acidity and drought.
- It should have a positive effect on bearing and quality of scion variety.
- It should possess good germination capacity, a high degree of polyembryony, ability to attend graft-able size in a short period and free from excessive branching.

Stock -Scion Relationships

A rootstock is part of a plant, often an underground part, from which new above-ground growth can be produced, and the plant part grafted onto the rootstock is usually called the scion. All the desired quality should have in the scion. A grafted or budded plant makes a good union to establish a composite plant when stock and scion is fully compatible. Sometimesgrafted or budded plant can produce unusual growth patterns which may be different from what would have occurred if each component part of a graftage. This different aspect of rootstocks will influence the performance of a scion cultivar or vice versa is known as stock-scion relationship.

A. Effect of Stocks on Scion Cultivars

1. Tree Size and Vigour

The specific rootstock can be used to regulate the size of the tree. In apple, rootstocks can be classified as a dwarf (2 m height), semi-dwarf (3-4 m height), vigorous (5 m height)and very vigorous (>5 m height) rootstocks based on their effect on a scion cultivator. The influences of rootstock on the size and vigour of a tree has been demonstrated in apple and citrus. If a scion is grafted on dwarf rootstocks, the graft combination will be dwarf while the same cultivar grafted on vigorous rootstock would grow very vigorously. Dwarf rootstocks (e.g. M 9) impart dwarfness in the scion. On the other hand, if the same scion is grafted on vigorous rootstock (e.g. M2), the scion grows very vigorously. Red Delicious, Jonathan and Rymer, when grafted on M 13, attend maximum girth, highest plant height, larger spread and higher plant volume. Trifoliate orange is the most dwarfing rootstock for

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sweet oranges and grapefruit. Rootstockskalarady, Olourof mango has been found to impart dwarfness in the scion cultivators. *Psidiumpuminum* is dwarfing rootstock of guava. Guava rootstock 'PusaSrijan' imparts dwarfness incv. Allahabad Safeda.

2. Precocity in Flowering and Fruiting

The time taken from plating to fruiting (Precocity) is influenced by rootstocks. The dwarfing rootstocks exhibit precocity and vigorous rootstocks delay in fruiting. In general, vigorous rootstock results in vigorous growth of the scion, which in turn offers more effective sites for blossom bud differentiation. Mandarin, when grafted on Jambheri rootstocks are precious than those grafted on sweet orange or sour orange or acid lime rootstocks.

3. Fruit set and yield

The production of flower and fruits set is directly influenced by rootstock in Persimmon (*Diospyrous kaki* cv. Hachiya). It produces more number of flowers when grafted on *D. lotus* but only few mature into fruits. Fruit set is very high when *D. kaki* is used as the rootstock. The effect of rootstock on yield has been reported in many fruit crops. Acid limes budded on rough lemon found 70 % improvement in yield as compared to budded on troyer citrange, rangpur lime or its own rootstock. Sweet orange var. Sathugudi gave higher yield when budded on Kichili rootstock than others. Trees on dwarfing rootstock may yield higher per unit area because more plants can be accommodated per unit area. The yield an increase of certain varieties of American grapes (*Vitislabrusca*) has been noted when they are grafted on vigorous rootstock than they are raised on their own roots. Golden Delicious produced more fruit per tree than gold spur on all three stocks (M 7, MM 106 and M 26).

4. Fruit size and quality

Sathugudi sweet oranges produced large fruit when grafted on gajanimma rootstocks, but the quality was poor while on its own roots they produced fruits with high juice content and quality. Sweet orange exhibited the highest granulation when budded on rough lemon whereas granulation was very low on Cleopatra mandarin. Rootstock *Pyruscommunis* did not show any symptom of physiological disorder black end in Bartlett Pear but*Pyruspyrifolia*exhibited this disorder and affected fruit quality. Washington navel oranges are found largest on Troyer citrange and smallest on Cleopatra mandarin. In general, when sour orange, sweet orange and grapefruit rootstock are used for sweet orange, fruits are

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smooth, thin-skinned, juicy with excellent quality and store well without deterioration, while sweet orange fruits on rough lemon are usually thick-skinned, coarse and inferior in quality having low acid and low sugar.

5. Nutrient status of scion

Rootstocks also influence the nutrient status of the scion. Root stock *C. volkarimariana* exhibits all nutrients in leaves of Sathugudi orange as compare to own rootstock or Cleopatra mandarin stocks.

6. Winter hardiness

Rootstocks are found to impart winter hardiness to the susceptible scion variety. Rangpur lime tolerated winter injury when grapefruit budded on it than on rough lemon or sour orange. Sweet oranges and mandarins on trifoliate stocks were colder hardies. Trifoliate orange is the hardiest rootstock of citrus. Apple rootstock, M-9 and M16 are resistant to winter injury.

7. Disease resistance

Rootstocks also exhibit variability in their response to diseases and nematodes. Rough lemon is tolerant many diseases like *Tristeza,* xyloporosis and exocortisbut susceptible to gummosis and nematode. Similarly, Troyer citrange is tolerant of gummosis but susceptible to exocytic virus disease. Guava rootstock Chinese guava (*Psidiumfriedrichsthalianum*) exhibits resistant to wilt diseases and nematodes. Rootstock MM 106, MM104, MM 109 and MM 111 of apple are resistant to wooly aphids. Myrobalan B is used as a rootstock for plum is resistant to bacterial canker. Similarly, Mahaleb rootstock is reported to be useful for cherries because of its resistance to the buckskin virus.

8. Ability to resist soil adverse conditions

Trifoliate orange is poorly resisted excess salt whereas sweet oranges, sour orange, rangpur lime rootstocks moderately resist excess salts in the soil. Rootstocks exhibit different response to excess soil moisture or excess boron in the soil. Rootstock Myrobalan plum tolerates to excess moisture and boron than Marianna plum, peach, apricot or almond.

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B. Effect of scion on rootstock

1. Vigour of the rootstocks

Apple produced a very fibrous root system with few tap roots when budded on apple cv. 'Red Astrachan' and when Goldenburg budded on the seedlings, they produced few tap roots without a fibrous root system. If the scion is less vigorous than rootstock, the growth and stature of the tree is determined by the scion rather than the rootstocks in citrus. Eureka lemon budded to sour orange seedling is killed along with the rootstock in severe winter, while the unbudded sour orange seedling suffers little from winter injury.

2. Cold hardiness of the rootstock

Scion affects cold hardiness of citrus roots. Unbudded sour orange seedlings are least affected from winter injury whereas when it is budded on Eureka rootstock, suffered much more from winter injury.

3. Precocity in flowering

A six month or one-year-old mango rootstock seedlings exhibited flowering when its branches were inarched from the old tree.

Conclusion

The scion-rootstock relationship is very important for optimal growth, nutrient uptake, flowering, fruiting and quality. A deficiency in mineral nutrients and water might cause suppressed growth of the scion and low carbohydrate concentrations in the root will decrease root growth, contributing to low water and nutrient uptake, and decrease the availability of carbohydrates as energy resources for the active uptake of ions. The scion– rootstock interactions may be exploited to obtain trees with particular architectures such as reduced branching but wide-angled trees. These stock-scion relationships are important from a horticultural point of view because they provide a basis for selecting the best graft combination for particular environmental conditions and high fruit quality. Selection of an appropriate graft combination is crucial for the production of deciduous orchard species because the scion–rootstock interaction influences water relations, leaf gas exchange, mineral uptake, plant size, flowering, fruit set, fruit quality and yield efficiency.

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