

Use of Root Stock in Fruit Crops

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Rootstock is the lower portion of the graft which develops into the root system of the grafted plant. A rootstock may be seedling, a rooted cutting or layered plant. It is also described a plant which already has an established healthy root system on to which a cutting or bud from another plant is grafted. The plant part grafted on to the rootstock is usually called scion. Rootstocks are being used in plant propagation for more than 20 centuries. It's may be a same or different species from the scion (Singh *et al.*, 2021).

Characteristics of an ideal rootstock

- It should exhibit a high degree of compatibility with scion cultivars and give maximum life to trees.
- It should be well adapted to climatic conditions of the particular region like frost, cold and heat.
- Should be resistant to disease and pest prevalent in the concerned area.
- Should be tolerant to adverse soil conditions like salt and drought.
- Must exhibit favourable and positive influence on the performance, bearing and quality of scion variety.
- Should possess good nursery characteristics like germination, high degree of polyembryony, ability to attain graft-able size in short period and free from excessive branching.

Importance of rootstocks in fruit crops

1. **Tolerance against biotic stress:** Losses due to insect pest and diseases can be minimized by using tolerant rootstocks which are well known in crops like citrus and grape. Rough lemon and Cleopatra mandarin have been found tolerant against tristeza, exocortis and xyloporosis. Nematodes are limiting factor in citrus production, which can be overcome by using trifoliate orange as rootstock. Several *Vitis* species show good resistance against nematodes. Freedom, Harmony and Dog Ridge are rootstock root knot nematode resistance. Different *Vitis* species are known for their ability to tolerate soil infestation of phylloxera and nematodes. In breeding new rootstock, the aim is to combine resistance to these pests along with other key traits. It is important to test new rootstocks for resistance to different races or biotypes of the pests before they are selected for use as rootstocks in evaluation.
2. **Improved fruit quality:** Rootstocks are sometimes important in the improvement of the fruit quality for crops like, grapes and citrus. There are several report which emphasized their influence on the improvement in quality through TSS, reducing sugar and acidity content of the fruits, Granulation in citrus is also indirectly influenced by the vigour imparted by the rootstock. Higher degree of the granulate in Jaffa sweet orange on Jatti Khatti as a rootstock.

3. **Increased scion yield efficiency:** Rootstocks influence the scion vegetative growth directly or indirectly and thus are decisive in manipulating yield efficiency. In several of the fruit crops, fruit yield per unit area has been found to be influenced by the rootstock. In citrus, the role of the Rangpur lime, Dogridge in grapes and Vellai Kolumban in Alphonso mango has proved the importance of rootstock in increasing scion yield efficiency. The vigour imparted to scion has direct relationship with the fruit yield because of more fruiting area. However, productivity index may vary with the rootstock efficiency to produce fruit per unit area.
4. **Wider adaptability:** Wider adaptability is one of the important characteristic of the rootstock for the successful adoption by the farmers. Rootstock with low multiplication rate and adaptation in limited geographical area may restrict the usefulness. There is a need of rootstocks for different crops with successful performance under biotic and abiotic stresses, beside adaptively to wide range of soils and climatic conditions.
5. **Improve salt tolerant:** The indiscriminate use of heavy quality of chemical fertilizer and the over exploitation of aquifers has dramatically multiplied of surface area affect by salinity. It is commonly accepted that growth inhibition by salt stress is associated with alteration in the water relationship within the plant, caused by osmotic effects with specific ionic consequences or energy availability related to carbohydrate concentration. Walker demonstrated that the rootstocks 'cleopatra mandarin' excludes Cl⁻ but not Na⁺. this suggests that the ability to exclude these two ions stems from different mechanisms. In India, grape rootstocks such as Dogridze and 110 R are presently being employed mainly to overcome the adverse effects of abiotic stresses like drought and soil salinity and to manipulate vigor of vine to some extent . Mango rootstocks '13/1' has relative high salt tolerance under field condition and makes mango cultivation possible under saline stress conditions also. It is a polyembryonic rootstocks commercially used in Israel and Egypt and has been tested in various regions of the world for tolerance in calcareous soils and saline condition.

Table 1: Some important recommended rootstocks for different fruit crops

Fruit crop	Rootstock	Distinct features
Mango	Creeping or Latara	Dwarfing
	Kurukkan	Polyembryonic and salt tolerant
	Olour	Dwarfing
	Rumani	Dwarfing
	Totapuri red small	Dwarfing
	Vellaikolumban	Polyembryonic, dwarfing and Allopolyploid
	Turpentine	Salt tolerant and dwarfing
	13 -1	Salt tolerant
	Gomera – 1	Polyembryonic and salt tolerant
Grape	Dogridge	Resistant to phylloxera, nematodes and salts
	Salt creek	Resistant to salt and nematodes
	St. George	Salt tolerant
	Riparia Glorie	Phylloxera resistant
	Temple	Resistant to pierce's disease of grape
	110 R	Resistant to drought and salt
	Fercal	An INRA hybrid rootstock, is highly resistant to phylloxera, nematodes and resistant to chlorosis.
Ber	<i>Zizyphus nummularia</i>	Give rise to inverted bottleneck disorder, which have been utilized for induction of dwarfing for HDP.
Guava	<i>Psidium friedrichsthalianum</i>	Dwarfing, resistant to wilt and nematode.
	Pusa srijan	Dwarfing and resistant to wilt.
	<i>Psidium pumilum</i>	Dwarfing
Jamun	<i>Syzygium densiflora</i>	Resistant to termite attack.

Sapota	<i>Manilkara hexandra</i>	Salt tolerance for dry region.
Annona	<i>Annona glabra</i>	Dwarf and resistant to wet and damp soil conditions.
	<i>Annona reticulata</i>	It can withstand adverse conditions and grows well in dry and arid regions.
Fig	<i>Ficus glomerata</i>	Resistant to nematodes.
Avocado	Mexican race	Winter hardy
Citrus	<i>Citrus unshiu</i>	Freeze tolerant
	Cleopatra mandarin	Salt tolerant
	Flying dragon	Dwarfing and suitable for HDP
	Rangapur lime	Salt tolerant
	<i>Severinia buxifolia</i>	Salt tolerant
	Trifoliate orange	Dwarfing and resistant to nematodes.
Apple	Alnarp -2	Semi – vigorous rootstock and winter hardy
	Jork – 9	Dwarfing
	M – 9	The best known dwarfing rootstock. It is known as the ‘Paradise’ rootstock of Europe. It is a cross between French tree, ‘Jaune de Metz’ and ‘Paradise’ apple of ancient Persia.
	M 27	Ultra dwarfing rootstock of apple. It is a cross between M 9 × M 13.
	M 20	Dwarfing. Unfit for HDP because of emergence of large number of suckers.
	Bemali	Dwarfing
	MAC – 1	Dwarfing
	MAC – 9	Semi – dwarfing
	Merton – 793	Semi - dwarfing
	Robusta – 5	Resistant to fire blight
	MM – 104, MM – 106, MM – 109, MM – 111	Resistant to wooly apple aphids.
	Northern spy	Resistant to wooly apple aphids.
	EMLA Rootstocks	Free from viruses
	BUD – 9	Dwarfing
	Pusa apple rootstock 101 (<i>Malus baccata</i> ‘Shillong’)	Low chilling type, high yield potential (25 tonnes / ha) and induces precocity.
	Bartlett	This is the most widely used rootstock for pears.
	Quince A	Most satisfactory rootstock
	Quince B	Semi – vigorous
	Quince C	Very dwarfing
	Oregon – 211	Dwarfing
	Oregon – 249	Dwarfing
Pear	Mahaleb (<i>Prunus mahaleb</i>)	Slightly dwarfing.
	Mazzard (<i>Prunus avium</i>)	Vigorous.
	Gisela – 6	Semi – dwarfing
	Gisela – 12	Semi – dwarfing. Precocious.
	Halford	Compatible with all commercially grown varieties.
	Chi Lum Tao	Very cold hardy.
Peach	Tzim Pee Tao	Very cold hardy.

	Lovel	Compatible with all peach varieties.
	Bailey	It is considered one of the best rootstocks for peaches in Ontario.
	Harrow blood	It is reported to standard peach clones by 20 %.
	Siberian C	It is reported as dwarf standard peach clones by 10 – 15 %.
	GF 677	It is a hybrid rootstock (<i>Prunus persica</i> × <i>Prunus amygdalus</i>) selected by INRA, Grande Ferrede, Bordeaux (France). Resistant to calcareous soils and drought conditions.
	GF 557	Nematode resistant
	Garnem	Tolerant to root – knot nematode. It is a hybrid between Spanish Almond ‘Garfi’ and Peach ‘Nemared’.
	Nemaguard	It is a root – knot nematode resistant rootstock.
	Nemared	It is a root – knot nematode resistant rootstock.
	Rubira	It is a root – knot nematode resistant rootstock.
	Okinava	It is a root – knot nematode resistant rootstock.
	Sharpe	
	Krymsac 86	Highly resistant to lesion nematode.
	Greenpac	<i>Prunus persica</i> × <i>Prunus davidiana</i>
	Flordaguard	
Plum	Pixy	Dwarfing rootstock
	St. Julien	Dwarfing rootstock
	Myrobalan	Drought tolerant
	Marianna 2624	Resistant to nematodes Brompton
	Brompton	Vigorous rootstock.
Almond	Alnem – 1	Resistant to nematodes
	Alnem – 38	Resistant to nematodes
	Alnem – 201	Resistant to nematodes
	GF 677	Tolerant to high soil pH
	GF 557	Tolerant to high soil pH
	Ishtara	Semi – dwarfing and precocious
	Behmi	Semi – vigorous
Apricot	<i>Prunus besseyi</i>	Dwarfing rootstock
	Torinel	Semi - dwarfing
	Hagghith	Cold hardy
	Marianna 2624	Resistant to bacterial wilt
	Marianna – GF 8/1	Resistant to bacterial gummosis
	Hybrid P – 2308	Dwarfing rootstock.
Cherry	Gisela – 10	Dwarfing rootstock
	Colt	Semi – vigorous
	F12/1	Vigorous
	Gisela 6	Improved fruit quality
	Gisela 5	Semi – vigorous
	Weihroot – 10	Semi – vigorous
Walnut	Paradox	Tolerant to drought and salts
Persimmon	<i>Diospyros virginiana</i>	Tolerant to salts and drought.

Conclusion

Rootstock play vital role in propagation of fruit crop. It protects the fruit crops from adverse effects of drought and salt stress. It helps to improve nutrient uptake from the soil and yield as well as quality of fruit. In fruit crops, rootstocks also give the tolerance against different biotic stresses.

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