

## Clonal Rootstocks of Temperate Fruit Crops

Nirmal Sharma<sup>1\*</sup>, Neeraj Kotwal<sup>2</sup>, Mahital Jamwal<sup>3</sup>, Sanjeev Kumar Chaudhary<sup>4</sup>, Satish Kumar Sharma<sup>5</sup>, Manoj Kumar Sharma<sup>6</sup> and Raj Kumar<sup>7</sup>

<sup>1,2,4,5,6</sup> Regional Horticulture Research Sub-Station, Bhaderwah, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu, J&K

<sup>3</sup> Directorate of Research, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu, J&K

<sup>7</sup> KVK-Ramban, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu, J&K

Corresponding Author: [fruitbreeding.12@gmail.com](mailto:fruitbreeding.12@gmail.com)

Rootstock is the lower part (rooted part) of a grafted/budded plant bearing root portion of the plant. Rootstock is equally important as that of scion in case of modern-day fruit cultivation because it imparts many desired effects on the scion cultivar. A rootstock appropriately chosen according to the planting needs leads to the success of an orcharding enterprise. Following are the important effects imparted by rootstock on the scion.

- 1. Size control:** If a scion is grafted on dwarf rootstocks, the plant will be dwarf while the same cultivar grafted on vigorous rootstock would grow vigorously. In apple, rootstocks are classified as a dwarf (upto 2 m tall), semi-dwarf (3-4 m tall), vigorous (5 m tall) and very vigorous (more than 5 m tall) rootstocks based on their effect on a scion cultivar (Fig. 1).

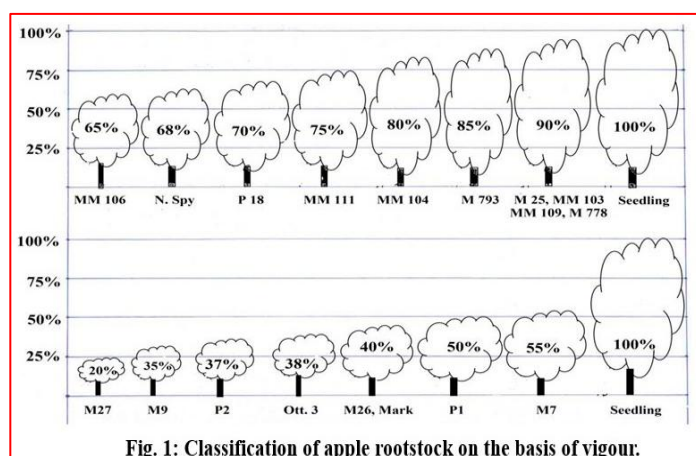


Fig. 1: Classification of apple rootstock on the basis of vigour.

- 2. Precocity:** The dwarfing rootstocks exhibit precocity and vigorous rootstocks delay the flowering and fruiting.
- 3. Productivity:** Dwarf trees are small in size so more plants can be accommodated per unit area as compared to vigorous plants. Rootstocks tolerant to biotic and abiotic stresses produces more quality crops. Thus, productivity is enhanced through adoption of suitable rootstock.

- 4. Tolerance to biotic stresses:** Large number of insect pests and disease affect apple plants like apple scab, powdery mildew, woolly apple aphid, mites, root rot, canker, root borer etc. Some rootstocks have been identified which are tolerant to these pests e.g. MM 106, MM104, MM 109 and MM 111 of apple have been found tolerant to woolly aphids.

- 5. Tolerance to abiotic stresses:** Under changing climatic conditions, one the major factor affecting quality and quantity of fruit crops are abiotic stresses. One of the sustainable management strategies to minimise losses due to abiotic stresses is adoption of rootstock tolerant to abiotic stresses. Apple rootstock M 9 and M 16 are found to be winter hardy and MM 111 has been found to be tolerant to drought.

Depending on the propagation method rootstock are of two types *viz.* seedling and clonal. Seedling rootstocks are those which are propagated through seeds (sexual means) and clonal rootstocks are those which are multiplied through asexual methods *viz.* cutting, layering etc. Though seedling rootstocks are equally important in temperate fruit cultivation, however, clonal rootstocks offer some advantages over seedling rootstocks such as uniformity and vigour reduction.

### Important clonal rootstocks for temperate fruit plants

#### Apple

- M27 (Malling 27):** A very dwarfing rootstock developed by crossing M9 and M13. Suitable for high density plantation but require stacking. If handled and spaced properly, it can be a very productive stock for a vertical axis training system.
- M9 (Malling 9):** Originated as a chance seedling, it is widely used dwarfing rootstock for apple. It has brittle and shallow roots

therefore needs proper staking. Root suckering is the problem. Susceptible to fire blight and can develop burrknots. Numerous clones of M.9 are now being sold by nurseries, including M.9 NAKB 337, the current dominant strain used. It is a virus-free clone from the Netherlands and is 5-10 percent less vigorous than M.9 EMLA.

- **M26 (Malling 26):** Produces plants 40-50 per cent as that on seedling rootstock. Developed by crossing M16 and M9 and produces trees smaller than M7. It is suitable for high density planting but requires stacking. It can be easily propagated by hardwood leafless winter cuttings. It is winter hardy but susceptible to woolly apple aphid and wet conditions. Weak growth causes sunburn problems.
- **M7 (Malling 7):** Semi-dwarfing rootstock produces plants larger than M9 and M26. It does not require stacking but susceptible to crown gall and crown rot. Prone to root suckering. It can be easily propagated by layering.
- **MM106 (Malling Merton 106):** Semi-dwarfing rootstock developed by crossing M2 and Northern Spy. Induces precocity in scion cultivar and easy to root. Free of root suckering problem. Tolerant to woolly apple aphid but susceptible to collar rot, so should be planted on well drained soils.
- **MM104 (Malling Merton 104):** Semi-dwarfing rootstock developed by crossing M2 and Northern Spy. It has well developed root system and propagates very well in stool beds. Very susceptible to collar rot but resistant to woolly aphid.
- **MM109 (Malling Merton 109):** Produces plants 90-100 per cent as that on seedling rootstock. Have wide adaptability. Performs well on low to medium potential soils and warmer areas. Easy to propagate through stooling. Woolly aphid resistant but susceptible to collar rot.
- **MM111 (Malling Merton 111):** Produces plants 70-80 per cent as that on seedling rootstock. Developed by crossing Northern Spy and Merton 793. Fairly easy to propagate

through layering and hardwood cutting. Drought tolerant, fairly resistant to woolly aphid and fire blight.

- **G.16 (G.5-A):** Similar to M 9 in tree size and precocity, but more resistant to Phytophthora root rot and fire-blight disease. Requires staking.
- **G65 (Geneva 65):** Considered to be as dwarfing as M27. The rootstock is difficult to propagate in nursery stool beds. It is susceptible to tomato ring spot virus and apple stem grooving virus.
- **B9 or Bud9 (Budagovsky 9):** B9 is a dwarfing rootstock developed by crossing M8 and Red Standard. Leaves are a distinctively red. Trees on this stock are 25 to 35 per cent smaller than M9 depending on the cultivar. B9 is said to be resistant to collar rot and is very cold hardy however need staking.

#### Pear

- **Quince C (QC):** Developed in United Kingdom, selected from *Cydonia oblonga* (quince). It is dwarfing and easy to propagate.
- **Adams 332:** Developed in Belgium, selected from *Cydonia oblonga* (quince). It is slightly more invigorating than Quince C but less than Quince A.
- **Quince A (QA):** Developed in United Kingdom, selected from *Cydonia oblonga* (quince). It is less invigorating than BA-29 but more than Quince C. It is drought and heat resistant. More productive than BP- rootstocks. It is good rootstock for poor soil or replanting situations.
- **Sydo:** Developed in France, selected from *Cydonia oblonga* (quince). Induces vigour similar to Quince A.
- **BA-29:** Developed in France, selected from *Cydonia oblonga* (quince). Slightly more invigorating than Quince A or Sydo. A semi dwarfing quince stock, propagated easily, compatible with all the commercially grown pears, induces precocity and tolerant to wide range of soil and 20-30 per cent more vigorous than Quince A.

- **Pyrodwarf:** Bred in Geisenheim, Germany from *Pyrus* spp.. Selected from the population of Old Home x Bonne Luoise. Low vigour, high precocity and high yield efficiency, uniform fruit size, good anchorage, winter cold hardy and good compatibility with all pear varieties.
- **Brossier series:** Developed in Angers, France from *Pyrus* spp. and vigour ranges from Dwarfing to invigorating.
- **BH, K and OH series:** Developed in Angers, France from *Pyrus* spp. as seedling selections of Beurre Hardy.
- **Old Home x Farmingdale (OHF):** Developed in USA from *Pyrus* spp. and are more invigorating than BA-29. Two clones (OHF 333 and OHF 59) are slightly less invigorating and are popular in some countries. They possess better graft compatibility, lower susceptibility to chlorosis and fire blight and are resistant to gall nematode. They are cold hardy and are difficult to propagate by layering and are thus propagated by cutting or through micro propagation.
- **BP. 1:** Developed in South Africa from *Pyrus* spp. It is susceptible to fire blight, resistant to collar rot. Dwarfing on poorer or shallow soils but difficult to propagate.
- **Ct. S 212 and Ct. S 214:** Developed in Pisa, Italy from *Cydonia oblonga* (quince). It is vigorous and tolerant to high soil pH.
- **Oregon series:** Oregon 211, Oregon 249, Oregon 260, Oregon 261 and Oregon 264 are high temperature tolerant, whereas, Oregon 211 x Oregon 249, Oregon 260, Oregon 261 and Oregon 264 are tolerant to drought, high soil moisture and low soil moisture. Oregon 211 x Oregon 249 is resistant to powdery mildew. Oregon series is resistant to crown gall and nematode and Oregon 249, Oregon 260, Oregon 261 and Oregon 264 are resistant to canker/gummosis. Oregon 211 is dwarfing in nature.
- **QR 193/16:** Developed in East Malling, UK from *Cydonia oblonga* (quince). It induces dwarfing and large fruit size in scion.

## Peach and Nectarine

- **GF 677:** A hybrid between Peach x Almond. Vigorous, tolerant to wet and dry soils and high soil pH, useful especially for replant situations. Suitable for replant situation. Susceptible for Phytophthora soil.
- **St. Julian Hybrid No. 2:** Semi-dwarf, tolerant to wet soils, salts and bacterial canker.
- **Marianna GF 8/1:** Vigorous, productive, precocious, resistant to water logging, viruses and root knot nematode.
- **Damas GF 1869:** Semi-dwarf, resistant to high soil pH, water logging and bacterial canker.
- ***Prunus persica* x *Prunus devidiana* hybrids:** Includes Nemaguard, Flordaguard, Barrier I, Cadman and GF 1869. Nemaguard, Flordaguard and Barrier I were developed in USA whereas Cadman and GF 1869 were developed in France.
- ***Prunus ceracifera* x *Prunus salicina* hybrids:** Include Ishtara and Myran which were developed in France.
- ***Prunus salicina* x *Prunus spinosa* hybrids:** Includes Jaspi, Mr. S. 215. Jaspi was developed in France and Mr. S. 215 was developed in Italy.
- **Citation:** Developed by crossing *Prunus persica* x *Prunus salicina* in USA.
- **Julio Ferdor:** Developed by crossing *P. institia* x *P domestica* in France.
- **PR 204:** Natural hybrid of Peach x Almond. Usefull in alkaline soils. Resistant to chlorosis and *Agrobacterium tumefaciencie*. Used in replant situations.
- **Hansen:** Peach x Almond hybrid. Tolerant to salinity, alkalinity, pH and boron soils.
- **MP-29:** A Plum x Peach hybrid. Semi-dwarf in its effect on scion.

## Plum

- **Ackermann's:** Semi-dwarf, low-medium productivity but susceptible to cold.
- **Black Damas:** Tree size large, productivity good. Resistant to bacterial canker.

- **Brompton:** Tree size very large, productivity average. Resistant to cold temperature but susceptible to bacterial canker.
- **Prune GF43:** Induces vigorousness. Resistant to root and collar rot, water logging but susceptible to Chlorotic leaf spot.
- **Pixy:** Tree size dwarf with good productivity. Tolerant to bacterial canker but susceptible to drought.
- **St. Julien A:** Tree size semi dwarf with average productivity. Resistant to low winter temperature.
- **Myrobalan:** Tree size large with good productivity and late ripening. Resistant to drought but susceptible to bacterial canker, oak root rot, cold and root knot nematode.
- **Myrobalan B:** Tree size large with good late ripening.
- **Myrobalan GF 31:** Tree size large with good precocious yield.
- **Marianna:** Tree size medium to large with very good early ripening. Resistant to rosette virus.
- **Mariana 2624:** Tree size smaller than peach with good, slightly early ripening. Resistant to water logging, oak root rot, prune brown line and root knot nematode but susceptible to bacterial canker.
- **Citation:** Induces dwarfness with good productivity.

### Cherry

- **Mazzard (F12/1):** Selected from *Prunus avium* at East Malling, England in 1920s. Vigorous rootstock. Requires many years (6-12 yrs) to come into full bearing.
- **Stockton Morello:** Selected from *Prunus cerasus* in Illinois. Tolerant of heavy, clay soils. Semi-vigorous but having poor anchorage.
- **Edabriz:** Selected from *Prunus cerasus* in France. Dwarfing and precocious. Less adapted to light, alkaline soils
- **Weiroot:** Selected from *Prunus cerasus* in Munich, Germany. Incompatible with some cultivars and not well adapted to heavy, clay soils.

- **Gisela 5:** Developed in Germany. Plants comes to bearing after 3-4 years. Likely to require staking for initial years. Plants approximately equivalent to the apple clonal rootstock M26 in size.
- **Gisela 6:** Developed in Germany. Similar to Gisela 5 but produces larger trees. Produces plants approximately equivalent to the apple rootstock MM106 in size.
- **Krymsk 5:** Developed in Russia. Similar to Gisela 6 but colder hardy and Semi dwarfing.
- **Colt:** Developed in Russia. Resistant to Phytophthora root rot, bacterial canker and virus. Produces plants approximately equivalent to the apple rootstock MM111 in size.
- **Mahaleb:** Selected from *Prunus mahaleb* in Southern and Central Europe. One of the most drought tolerant cherry rootstock. Slightly less vigorous than Mazzard. Extremely sensitive to water logged soils.
- **F12/1:** Developed in England. It is a vegetatively propagated selectin of Mazzard. Preferred over Mazzard due to its resistant to bacterial canker and plants start full production after about 7 years.

### Almond

- **Nemguard:** Vigorous and immune to root knot nematodes. Compatible with all almond varieties. Performs well in sandy loam and loam soils.
- **Lovell:** Produces plants about 90 per cent of the size of Nemaguard in sandy loam soils. A little better than Nemguard in heavy soils. Highly susceptible to root knot nematode. More tolerant to ring nematode than most other commercial stocks.
- **Peach almond hybrid:** Produces vigorous plants. Tolerant to alkaline, high boron, sodium and chloride conditions. Roots have very good anchorage. Resistant to root knot nematode.
- **Krymsk 86 (Plum × peach hybrid):** Produces plants about 80-90 per cent of the size on Nemaguard (Similar to Lovell). Tolerant to



heavy soils and root rot. Roots has very good anchorage. Produces very little suckers.

- **Barrier I (Empyrean I):** More vigorous than Peach almond hybrids. Resistant to root knot nematodes and tolerant to sodium and chloride conditions.
- **Viking:** Developed as complex hybrid of peach × almond × plum × apricot. Produces plants similar in size to Nemaguard. Roots have good anchorage. Resistant to root knot nematode. Tolerant to ring nematode. Bacterial canker tolerance is similar to Lovell but with higher yield. More tolerant to high pH, sodium and chloride than peach rootstocks.
- **Atlas:** Developed as complex hybrid of peach × almond × plum × apricot. More tolerant to high pH, sodium and chloride conditions as compared to Nemguard. Resistant to root knot nematode but susceptible to ring nematode and bacterial canker.

## Walnut

- **Paradox (*Juglans hindsii* × *Juglans nigra*):** Resistant to root lesion nematodes and crown gall. Tolerant to salinity and heavy wet soil. Reported to induce better yield than others with larger size nuts.
- **Valch (*Juglans hindsii* × *Juglans regia*):** It is the first Paradox clone to be micro-propagated. Induces vigorousness with high survival rate. High disease tolerance but susceptible to nematodes
- **VX211 (*Juglans hindsii* × *Juglans regia*):** Has shown high survival rate in replant conditions. Reported to increase production. Tolerant to phytophthora and nematodes.
- **RX1 (*Juglans microcarpa* × *Juglans regia*):** Produces smaller trees with less vigorousness than VX211. Has shown excellent survival in replant conditions.

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