सत्यमेव जयते

YEAR of HORTICULTURE 2012

Protocols and Standards for Vegetative Propagation of Fruit Crops

Dr. Gorakh Singh

Department of Agriculture & Cooperation
Ministry of Agriculture
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Horticulture Commissioner

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FOREWORD

Horticulture sector in India has now gained credibility due to its recognition as a source of sustainable income, nutritional security and employment opportunities, both in rural and urban areas.

The productivity of fruit crops depends on several factors, of which quality planting material is indisputably the most important. In spite of the presence of large number of nurseries and seed gardens, presently only 35 to 40% of demand for quality planting material is being met from the existing infrastructure. Farmers do not have adequate access to certified quality planting material. This necessitates the need to focus on the establishment of strong nursery infrastructure during the 12th Five Year Plan to boost fruit production in the country.

Vegetatively propagated fruit crops have immense potential in enhancing fruit production. Considering the perennial nature of fruit crops, it is essential to choose right cultivars and quality planting material to ensure higher yields and quality of produce. Ensuring true-to-type and clean planting material, free from diseases, is critical. Government of India has been addressing this aspect under National Horticulture Mission and Horticulture Mission for North East and Himalayan States. These initiatives of the Government have led to some improvement in the availability of high yielding, disease free and healthy planting material. Needless to emphasize, much more needs to be done.

In this backdrop, I am happy to note that this manual on protocols and standards for vegetative propagation of fruit crops is being brought out by the Horticulture Division of the Department of Agriculture and Cooperation. This will serve as an extremely useful guide for all the stake holders involved in the adoption of different vegetative propagation techniques for production of clean planting material. My compliments to Dr. Gorakh Singh, Horticulture Commissioner for this endeavour at the beginning of 12th Five Year Plan period.

(P. K. Basu)

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Protocols and Standards for Vegetative Propagation of Fruit Crops

Protocols and Standards for Vegetative Propagation of Fruit Crops

Introduction

Over a period of time, there has been a continuous increase in the demand of horticultural products in the country. This is largely due to rise in population, increase in household income and the growing sensitivity towards nutritional security. Since there is not much land available for expansion, the increase in production must be achieved by increasing the productivity levels. There is ample scope for improvement in this area because, as of today for most fruit species, the present yields are far below the world average. Enhanced productivity would also make the production process more cost competitive. Simultaneously, due attention must be paid to improve the quality of produce. One of the most important factor contributing towards high productivity of the fruit crops is the quality of the planting material. Therefore, farmers must be provided with superior quality disease-free planting stock of high yielding varieties.

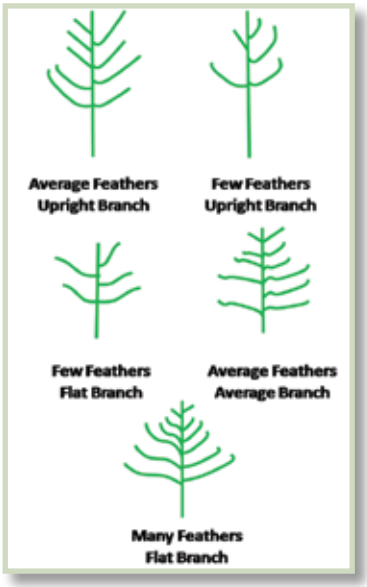
Fruit crops, mostly being perennial in nature, call for utmost care in selection of varieties, quality planting material, adoption of right technology for mass multiplication of planting material. Mistakes committed during the initial establishment of orchard cannot be corrected and will cause serious damage to production and productivity. In spite of the large number of nurseries, both in public and private sectors, there is still acute shortage of quality planting material and lack of proper mechanism for dissemination of production technology for mass multiplication of disease free planting material of fruit crops.

Quality Planting Material – An Important Indicator for Higher Productivity

Tree quality is usually defined by the tree caliper (diameter of the trunk/stem), the number of feathers (branches) and angle of the feathers, which are most important criteria in evaluating tree quality. The production of feathers depends on climate and cultural practices right from nursery stage. The number of feathers on a tree is generally thought to be correlated with vigour.

Why Quality Planting Material?

Improvement of technology base and other strategies being recommended will not have the desired impact unless quality planting material is made available. In most of the cases quality planting material now being supplied is poor both in respect of genetic values and health



Graphical representation of feathers

standard, besides high variations within the cultivar. There is also a degeneration of varieties in certain cases. Variations are also observed in productivity and quality amongst the trees of a selected variety. It is, therefore, necessary that the best tree or Tree of Outstanding Merit (TOM) within each variety be selected, earmarked and used as mother tree for future multiplication.

Criteria for Selection of Mother Plant

Selection of mother plant is to be given top priority as it decides the fate of the production efficiency in fruit crops. The performance will depend on the source of scion material which should be taken from the tree fulfilling all the scientific criteria for the best performance. These are:

- The mother plant must have been tested for its performance over a number of years.
- It must be free from transmittable diseases and be in a healthy condition.
- The fruit shape, size and quality must conform to the typical specification of the variety.

Primary Considerations of Quality Planting Material

Quality planting material should comply with the following three parameters that should be taken into account by the buyer, the seller and the quality controller.

Variety: Planting material should contain only the desired variety. In addition, the material should originate from plants with superior production, resistance and quality traits. Acquisition of improved planting material is an opportunity to upgrade production potential of the variety. Certain high rate multiplication techniques can be used to multiply selected plants with elite characters.

Size and uniformity: The planting material should have the size and uniformity appropriate to the objectives and resources of the grower.

Disease: The material for planting or any associated rooting medium should not be a source of disease and insect pest.

Establishment of Mother Block

Invariably, separate space should be provided for establishment of mother block with desirable characteristics of varieties within the premises of the nursery. This is one of the most important inputs which decides the fate of production efficiency of fruit orchards. Therefore, high yielding clones of recommended varieties

Mother block of mango, guava and citrus

Mother block of citrus in greenhouse

Clonal rootstock – MM 111

from different locations should be selected for developing new mother block. The selected plants should be planted in a closer spacing in order to get continuous supply of scions. These plants should be severely pruned to keep them in vegetative phase and to produce enough shoots for propagation purposes. The maintenance of mother blocks should be done rigorously so that plants are healthy and free of diseases and insect pests. A permanent register indicating the layout of promising varieties of the region should be maintained. The maintenance of mother plants, right from the time of planting to the stage of bearing and subsequent years involves application of manures and fertilizers, weeding and inter-culture operations, training and pruning and effective plant protection measures. Proper record of each variety should be maintained by making layout of maps in the nursery register.

Establishment of Clonal Rootstock Banks

Clonal rootstocks are widely used today to overcome adaptability problems. Clonal rootstocks are genetically identical clones of a parent rootstock. These rootstocks are special because they have certain desirable characteristics including tolerance to winter cold, high temperature, poorly drained soil, heavy clay or salty, or very dry soil or pests and diseases. The ultimate tree size can be controlled by the rootstock. It is, therefore, necessary to select the right rootstock for the condition in the area, so that growers can greatly enhance productivity with quality production. There is a need to establish separate mother stool beds for mass multiplication of virus and disease free promising rootstocks by stooling and cutting.

CHARACTERISTIC OF RECOMMENDED CLONAL ROOTSTOCKS

Fruit Crops	Rootstock	Characteristic
Apple	M 9	Short juvenile phase, dwarfing suitable for high-density planting
	M 7 and MM 106	Semi dwarf, suitable for high density planting resistant to wooly apple aphid
	MM 111	Semi dwarf, drought tolerant and resistant to wooly apple aphid
	MM 116	Semi dwarf, resistant to wooly apple aphid and collar rot
	M 793	Vigorous, resistant to wooly apple aphid and collar rot
	Crab apple	Cold tolerance
Pear	BA 29	Semi dwarf, resistant to crown galls and nematodes
	Quince A	Medium, vigorous

Fruit Crops	Rootstock	Characteristic
	OH x F-230	Semi-dwarf, highly tolerant to winter cold and canker, moderately tolerant to collar rot and crown gall
	Oregon-260	Vigorous, highly tolerant to wet and dry soils; bacterial canker, collar rot, crown gall and root lesion nematode
	Oregon 211	Dwarfing, highly tolerant to wet soils, crown gall, collar rot, root lesion nematodes
Cherry	Colt	Semi dwarf, compatible with all varieties, resistant to gummosis and crown-rot
	Mazzard F 12/1	Semi dwarf
	Charger	Semi dwarf, wide compatibility, easy in propagation, resistant to bacterial canker
	Weihroot 10	Semi vigorous, good compatibility, cold hardy, resistant to root rot
	Gisela 10	Dwarf, highly productive and winter hardy
Plum	Mirabi	Semi dwarf, tolerant to water logging vigorous, tolerant to drought
	Myrobalan 27	Vigorous, tolerant to drought
	Myrobalan GF 31	Vigorous, productive, good compatibility and tolerant to high soil moisture
	Pixy	Dwarf
	St. Julien 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
Peach	GF 557/677	Vigorous, tolerant to wet and dry soils and high soil pH. Useful especially for replant situations
	St. Julien 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
	Cyberian C and Rubia	Dwarf
	Damas GF 1869	Semi dwarf, resistant to high soil pH, water logging and bacterial canker
Almond	GF 677	Vigorous, tolerant to wet and dry soils
	Hansen 2168	Vigorous, tolerant to root knot nematode and relatively low chilling
	Ishtara	Semi dwarf, precocious and resistant to root knot nematode
Apricot	Myrobalan GF 31	Vigorous, productive, good compatibility and tolerant to high soil moisture
	Marianna GF 8/1	Vigorous, productive, precocious, resistant to water-logging, viruses, and root knot nematode
Walnut	Paradox	Vigorous, disease resistant and tolerant to salts and drought
Pecan Nut	Carya acquiatica	Adaptability to wide range of soils, particularly to wet soils

Establishment of Polyembryonic Rootstock Bank

Polyembryonic, as the name indicates, refers to the seed having more than one embryo. One of the embryos arises from the union of male and female gametes and is called gametic or sexual embryo, whereas the others are produced by simple mitotic division of cells of nucellus without the help of male gamete in their formation. The phenomenon of nucellar embryo is of common occurrence in citrus.

In general, the nucellar seedlings are identified or in other words the zygotic seedlings are rouged out of nursery in step-by-step approach. In this method, the majority of the seedlings which fall within one vigour group and are more or less of the same size are considered to be nucellar. Others which are either too small or too tall than the commonly prevailing type are discarded and considered to be off type or zygotic. To eliminate gametic seedlings, first rouging should be done when they are about 10 to 20 cm tall and ready for transplanting in the nursery. The second rouging should be done at the time of budding and grafting, while third and final rouging should be done at the time of transplanting in the field. The optimum performance of a variety depends on a proper selection of rootstock for a given set of growing conditions. It is, therefore, important to establish a separate rootstock block suited to a particular location so that the threat of dieback can be minimized. Cultivars have been identified, which may not have edible fruit, but are excellent rootstock plants. Recommended rootstocks of citrus are given below:

Raising Polyembryony rootstocks of citrus

Citrus Rootstock	Recommended for
Rangpur lime	Sweet orange/khasi mandarin
Rough lemon	Mandarin/Sweet orange
Cleopatra mandarin	Mandarin/kinnow
Troyen citrange	Kinnow
Volkameriano/ Sohmyndong	Khasi mandarin

Vegetative Propagation

The propagation of plants by the method other than sexual propagation is referred as vegetative or asexual propagation. It involves no change in genetic makeup of the new plant. All the characteristics of the mother plant are reproduced in the progeny plant due to exact duplication of chromosomes during cell division. Thus, the plants are true-to type in growth, fruiting and fruit quality.

In vegetative propagation of perennial fruit crops, one plant is selected for its root system, which is called stock or rootstock. The other plant is selected for its shoot system which is called scion. The scion contains the desired genes to be duplicated in future production by the stock/scion plant. For successful grafting to take place, the vascular cambium tissues of the stock and scion plants must be placed in close contact with each other. Both tissues must be kept alive until the graft has 'taken off', which usually takes few weeks. Successful grafting only requires a proper vascular connection between the grafted tissues.

Raising of Rootstock Seedlings for Grafting or Budding

The propagation through seed is primarily done to raise open pollinated/polyembryonic seedling rootstocks required for grafting/budding operations. Raising rootstocks in poly bags is recommended as these give better establishment of plants in the field on account of undisturbed root system. In some species, seeds have hard coating over the endocarp as a result of which usually long time is required for germination. Soaking of seeds in water followed by covering poly bag/seed bed with white polythene sheet is recommended and early and better germination.

Technique of seed sowing

Recommended Propagation Techniques and Rootstocks for Fruit Crops

Fruit Crops	Commercial Propagation Techniques	Type of Rootstocks
Almond	T-budding and wedge grafting	Open pollinated peach and bitter almond seedlings
Aonla	Patch budding and wedge grafting (winter)	Open pollinated seedlings
Apple	T-budding/tongue and wedge grafting	Clonal rootstocks
Apricot	T-budding and wedge grafting	Open pollinated apricot/peach/plum seedlings
Avocado	T-budding and wedge grafting	Open pollinated seedlings
Bael	Wedge grafting	Open pollinated seedlings
Banana	Suckers/corm	An elite mother plant, free from diseases, producing large sized quality fingers
Cashew	Soft wood grafting	Open pollinated seedlings
Cherry	Tongue and wedge grafting	Clonal rootstocks
Custard apple	Wedge grafting	Open pollinated seedlings
Date palm	Sucker/off shoot	An elite mother plant, free from diseases, producing large sized quality fruits
Fig	Hard wood/semi-hard wood cutting	An elite mother plant, free from diseases, producing large sized quality fruits
Grape	Hard wood cutting and wedge grafting (for in-situ/bench grafting)	110R and Dogridge (for wedge grafting) An elite mother plant, free from diseases, producing large sized quality berries (for cuttings)
Guava	Wedge grafting	Open pollinated seedlings
Gooseberry	Hardwood/semi-hard wood cutting	An elite mother plant, free from diseases, producing large sized quality fruits
Jackfruit	Patch budding and soft wood grafting	Open pollinated seedlings

Fruit Crops	Commercial Propagation Techniques	Type of Rootstocks
Jamun	Soft wood grafting	Open pollinated seedlings
Khirnee	Soft wood grafting	Open pollinated seedlings
Kiwi fruit	Hard/semi hard wood cutting and budding	An elite mother plant, free from diseases, producing large sized quality fruits. Open pollinated seedlings (for budding)
Lemon/lime	Cutting and budding	An elite mother plant, free from diseases, producing large sized quality fruits (for cuttings). Open pollinated seedlings (for budding)
Litchi	Air layering and wedge grafting	Open pollinated seedlings (for wedge grafting)
Mahua	Soft wood grafting	Open pollinated seedlings
Mandarin	T-budding and wedge grafting	Polyembryonic seedlings
Mango	Soft wood, wedge and veneer grafting	Open pollinated seedlings and Polyembryonic (13–1, Vellaikulumban)
Peach	T-budding, wedge and tongue grafting	Clonal rootstocks
Pear	T-budding, wedge and tongue grafting	Clonal rootstocks
Pecan nut	Patch budding and wedge grafting	Open pollinated seedlings
Pineapple	Slip/sucker	An elite mother plant, free from diseases, producing large sized quality fruits
Plum	T-budding, tongue and wedge grafting	Clonal rootstocks
Pomegranate	Wedge grafting/air layering	Open pollinated seedlings (for wedge grafting) and an elite mother plant, free from diseases, producing large sized quality fruits (for air layering)
Raspberry, Blackberry	Sucker	An elite mother plant, free from diseases, producing large sized quality fruits
Sapota	Wedge grafting	Khirnee seedlings
Strawberry	Runner	An elite mother plant, free from diseases, producing large sized quality fruits
Sweet Orange	T-budding/wedge grafting	Polyembryonic seedlings
Wood apple	Soft wood grafting	Open pollinated seedlings
Walnut	Patch budding and wedge grafting	Wild seedlings and Paradox

Propagation Structures

Greenhouse has revolutionized the nursery sector in different parts of the country and has become an integral part of nursery activities. With the advantages of greenhouse technology, the efficiency of nursery has improved tremendously. The limitation of propagating seasons has been overcome by enabling mass multiplication of plants almost throughout the year in greenhouse.

Poly houses (Forced ventilated with evaporative cooling system)

Naturally ventilated greenhouse

Polycarbonate structure fitted with cooling, misting and heating system

Fruit crop propagation is hampered by extreme weather variations and seasonal vagaries like drought, frost and hot winds. Greenhouse provides protection to the nursery plants from these exigent situations and gives additional benefit for off-season propagation. Grafting or budding operations of fruit crops under polyhouses or low cost greenhouses with natural ventilation enhances the percentage of graft or bud take off besides faster growth due to favourable micro climatic conditions of polyhouse. Greenhouse may be plastic polyethylene covered or made from fiberglass or other appropriate covering material. Hi-tech greenhouses are well equipped with elaborate instruments and have precise control on temperature, light intensity and humidity. Several variety of sheets are available for their construction like UV stabilized polyethylene, polycarbonate and fiberglass. These are lightweight and inexpensive as compared to glass.

Citrus

Shadenet Houses

Shadenet houses in nurseries offer many advantages like raising of seedlings in bags directly, protecting the grafts from hot summer months, effective irrigation through upside down overhead micro sprinklers. The shadenet houses with 50% or 75% of shade are particularly very useful in arid regions where the humidity is very low during summer months and help in maintaining the freshness and appeal of the plants.

Walnut

Protocols for the Production of Planting Material

Techniques for commercial multiplication of quality planting material in various fruit crops have been developed and standardized for the establishment of new orchards.

Air Layering

In this method, roots are formed in the aerial part of the plant. One year old, healthy and straight shoot is selected and ring of bark measuring about 2.5 to 4 cm just below a bud is removed. The cut is then surrounded by mud ball containing sphagnum moss (2 parts of dam moss and 1 part of soil) and is wrapped with a polyethylene strip (200–400 gauge). Both ends are tied with fine rope or rubber bands to make it practically air-tight. If sphagnum moss is not available, any other material, which can retain moisture for long period of time, can be used for this purpose. The polyethylene covering does not allow

Removal of outer bark of shoot, covering with moss grass, wrapping with polythene & tying ends of polythene with rope

Rooting in air layers

Trench layering

the moisture to come out but permits gas exchange. Moreover, the layers need not be watered afterwards, which saves considerable labour. This method of layering is also known as goottee method.

February–March and July–August months are ideal for air-layering. After a few weeks roots develop which are visible through the polyethylene covering. Then a half way cut should be given to the rooted layers on the parent branch at least 15 days prior to their permanent removal from the mother plant. At the time of separation, few leaves or small shoot is retained. It is also advisable to plant these rooted layers in nursery under close supervision before planting them directly in field. These layers can be planted in the fields during the following year in February or September–October.

Air layers ready for planting

Trench Layering

In this method, a branch is laid horizontally in a small trench to encourage the development of several new shoots from it. As these shoots grow, soil is filled around them and roots eventually develop. The little plants can then be removed from the original branch after roots have formed. This method is used primarily for fruit trees which are difficult to propagate by other methods.

Mound Layering/Stooling

In this method, plant is headed back to 20–30 cm above the ground level during dormant season. The new shoots come out within 2 months after heading back. These sprouts are then girdled near base and rooting hormone (IBA), made in lanolin paste is applied to the upper portion of cut with moist soil. These shoots are left as such up to two days for proper absorption of rooting hormone before these are covered with moist soil. The concentration of rooting hormone varies from plant to plant. However, generally 3,000–5,000 ppm is most commonly used. The rooting of shoots is observed within 20–30 days. After 2 months, the rooted stools are

Multiplication of rootstock through mound layering

separated from mother plants and planted in nursery. The stooling is used in the commercial production of clonal rootstocks of temperate fruit crops.

Budding

Budding is a method in which only one bud is inserted in the rootstock. As soon as the bark starts slipping both on the stock and scion, this is considered to be the optimum time for budding. This shows that the cambium, which is the tissue responsible for union, is active. The common methods of budding are T-budding and patch budding.

Removal of bud, fixing in rootstock tying with polyethylene strip and successful graft

T-Budding: This is also known as shield budding. A horizontal cut about 1/3rd the distance around the stock is given on the stock at about 15–20 cm above the ground surface. Another vertical cut 2–3 cm in length is made down from the middle of the horizontal cut and flaps of the bark are loosened with ivory end of the budding knife to receive the bud. After the 'T' has been made in the stock, the bud (with the petiole stub intact) is removed from the bud stick. To remove the shield of bark containing the bud, a slicing cut is started at a point on the bud stick about 1.25 cm below the bud, continuing underneath about 2.5 cm above the bud. A second horizontal cut is then made 1.25 to 2 cm above the bud, thus permitting the removal of the shield piece. The shield is removed along with a very thin slice of wood. The shield is then pushed under the two raised flaps of bark until its upper horizontal cut matches the same cut on the stock. The shield should fix properly in place, well covered by the two flaps of bark, but the bud itself exposed. The bud union should be wrapped with polyethylene strip to hold the two parameters firmly together until the union is completed. T-budding can be performed at any time of the year provided cell sap flows freely.

Citrus budded plant

Patch Budding: Seedlings of about one year of age, uniform and active in growth are selected for the budding purpose. The thickness of the shoot should not be more than that of an ordinary lead pencil. This method is most satisfactory when vigorously growing plants of 1.25–2.5 cm in diameter are used as stock. It is better to take well swollen and unsprouted dormant buds from the leaf axil of mature one-year-old twigs of the scion variety.

Technique of patch budding

A patch size of approximately 1 x 1.5 cm is ideal for patch budding. Similarly, same sized patch is removed from the rootstock and bud is fitted into it. Bud should be fitted at a height of nearly 15 cm above the ground level. Polyethylene tube is used for keeping the buds close to the stock. When the bark adheres tightly to the wood, budding is usually successful. After about 2–3 weeks of budding, the polyethylene tube is opened to examine the success. In successful cases, about one-third of top portion of shoot of the rootstock can be removed for forcing the growth of buds. The remaining two third portion can be

removed after three weeks from the first cutting, leaving about 2–3 cm above the bud. The best time for budding is May, July and August.

Grafting

Veneer grafting: The method is simple and can be adopted with success. However, several factors like age

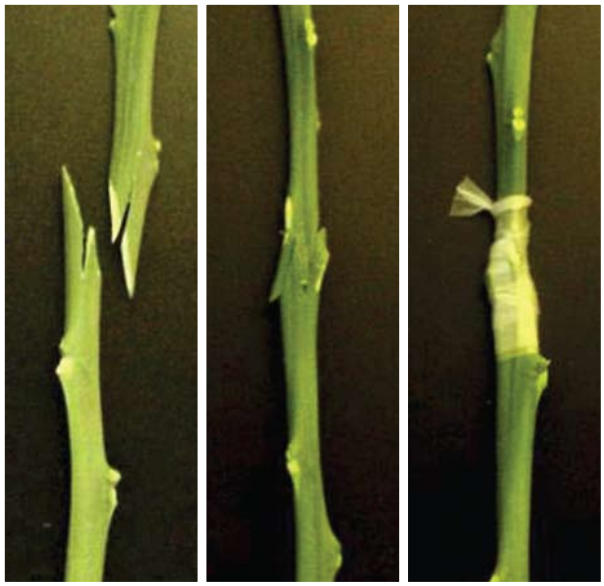
Preparation of rootstock, and scion & securing the graft with polyethylene

and thickness of scion, time of grafting, defoliation period of scion stick are important in governing the grafting success. The rootstock of about one year old age is suitable for this method. However, if the stock attains suitable thickness (about 1 cm) earlier than a year, can be used for rootstock. Better success is obtained with a scion stick of 4–6 months of age. The scion sticks are pre-defoliated for making the axillary and apical buds active. For conducting this grafting operation, a downward and inward 30–40 mm long cut is made in the smooth area of the stock at a height of about 20 cm. At the base of cut, a small shorter cut is given to intersect the first so as to remove the piece of wood and bark. The scion stick is given a long slanting cut on one side and a small short cut on the other so as to match the cuts of the stock. The scion is inserted in the stock so that the cambium layers come on the longer side. The graft union is then tied with polyethylene strip as recommended for inarching. After the scion remains green for more than 10 days, the rootstock should be clipped in stages.

Mango

Soft wood grafting: In this case, grafting is done on newly emerged flush having bronze coloured leaves and stem. This method is useful for *in situ* grafting while establishing new orchards with already established rootstocks in the field. For establishment of orchards in dry conditions, softwood grafting can be useful on pre-established rootstock. The scion wood to be used should be defoliated 10 days prior to the grafting with same thickness as that of terminal shoot. The graft should be secured firmly using 1.5 cm wide, 200-gauge polyethylene strip. July and August months with high humidity and moderate temperature are the best for the success of softwood grafting.

Tongue grafting (Splice/Whip grafting): It is the predominant propagation method used in apples and widely used in pear. This method is commonly used when the stock and scion are of equal diameter. Each scion stick should contain at least two to three sets of buds. Identical cuts are made at the top of the rootstock and bottom of the scion, so the two pieces fit together nicely. Try to make this cut with one stroke of the knife. First, a long, smooth, slanting cut of about 2.5 to 5.0 cm long depending on the crop is made on rootstock. Another downward cut is given starting approximately 1/3rd from the top and about a centimeter in length. Similar cuts are made in the scion wood exactly matching the cut given in the rootstock. The scion having 2 to 3 buds is then tightly fitted with the

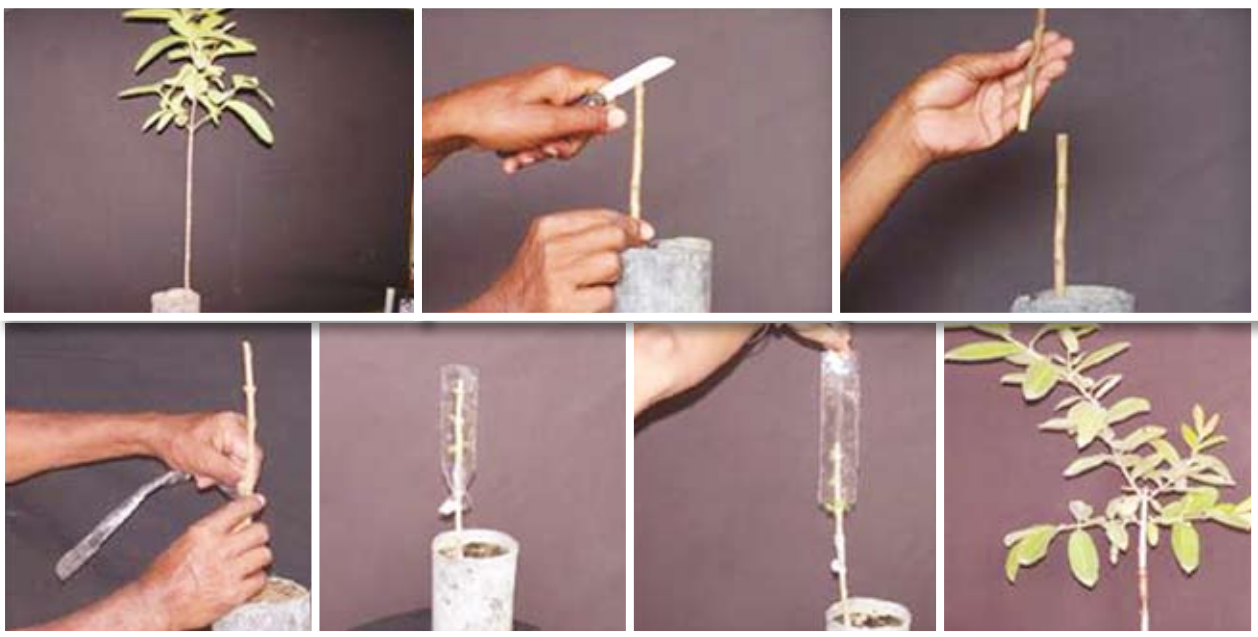


Technique of tongue grafting

rootstock taking care that the cambium layer of at least one side of the stock and scion unites together. This is then wrapped with polyethylene strip. Tongue grafting is done in March–April in high hills and dry temperate zone while February–March in lower elevation.

Wedge grafting: Wedge grafting is a relatively easy method of propagation. In this technique, proper selection and preparation of scion sticks is very important for obtaining higher success of graft. With the introduction of wedge grafting technology, rapid multiplication of plants has been made possible throughout the year. The technology of wedge grafting has been proved to be a boon for nurserymen. This technology has overcome seasonal barriers and planting materials could be raised throughout the year either in greenhouse or under open field conditions. Polyethylene caping facilitates early sprouting and ensures 90–100 per cent success rate of grafts.

After selection of the scion, rootstock (seedling) is headed back by retaining 15–18 cm long stem above the polythene bag. The beheaded rootstock is split to about 4.0–4.5 cm deep through the centre of the stem with grafting knife. A wedge shaped cut, slanting from both the sides (2.5–4.5 cm long depending on the crop) is made on the lower side of the scion shoot. The scion stick is then inserted into the split of the stock and pressed properly so that cambium tissues of rootstock and scion stick should come in contact with each other. Care must be exercised to match the cambium layer of the stock and scion along with full length of each component. The union



Selection of stock, splitting of rootstock, preparation scion, tying of graft union, sprouting of scion, removal of plastic cap and ready for planting material

Mass multiplication of fruit crops through wedge technique

is then tied with the help of 150 gauge polythene strip, 2 cm in wide and 25–30 cm in length. Immediately after grafting, the graft is covered with 2.5 x 18.0 cm long white polythene cap which is tied with rubber band at the lower end. The scion starts sprouting after 9 to 12 days which is visible from outside. The cap is removed after 25–50 days depending on the crop in the evening hours. The grafts are transferred into net house for hardening. All grafts may not take successful union. In some cases, scion dies due to incompatibility with the stock, desiccation, poor cambial contact or other causes. Rootstock of failed graft can be reused. They are beheaded from just below the graft portion to reactivate growth. This rootstock may be re-grafted after five months.

Grafting - What can go wrong?

The two parts may not unite and the plant may die due to:

- Incompatibility of the root stock and scion/bud.
- Lack of sufficient cambial contact due to improper cuts or/and unfit joint.
- Desiccation of the graft union.
- Water soaking or infection at graft joint.
- Drying of plants due to lack of watering or dry condition.
- Drying of scion/bud before grafting.
- Use of weak or bad rootstocks.

Scion quality

Guidelines for selection of good scion material:

- Scions should be selected from elite trees known for uniform and high bearing quality fruits.
- Scions wood should be selected from trees free from any bacterial, fungal and viral diseases as well as insect and pests.
- The scions should be selected at dormant stage (temperate fruit crops) for grafting.
- Scions should be taken from the upper/exposed part of the tree.
- Scions should be taken from vigorously growing branches.
- Scion diameter should be according to the size of the stock.
- Scions should be without flower buds.

- Scions should have well developed vegetative buds in a dormant stage.
- The scions should be kept moist and cool until the grafting takes place.
- Grafting should be done as soon as possible after collection of scion material.

Important points in grafting

- The cambium layers of the stock and scion must be properly placed in contact with each other to ensure a union.
- Binding should not be very tight or left on for long time, as to impair or stop growth.
- Use only healthy scion shoots.
- Grafting should be done at the proper time, which is when the rootstock begins active growth.
- Grafting tools should be sharp and clean.
- Provide proper protection to the graft until the union is sufficiently strong to support itself.
- Cover the graft with polythene cap for early sprouting and better success of grafts.

Scion shoot covered with poly cap

Care of grafted plants

- Grafted plants are susceptible to evaporation from the cut until callus has been formed to close the wound. Therefore, it should be kept in a humid atmosphere until the two parts have grown together. In the nursery, they can be kept in a humid atmosphere in a mist house. In the field, the grafted plant can be covered by a plastic cap.
- After the parts have united, the wrapping material should be removed and the plants still be kept in the nursery for some time to harden.
- Normal nursery practices of watering, root-pruning etc. should be carried out until the plants are planted out.
- Shoots and branches that grow out from the root stock, i.e. below the grafting point should be removed. In order to help in identifying the graft union for a long time, the place of union may be painted.
- If flowers occur in the first year or before the vegetative parts have been sufficiently developed, they should be removed.
- When grafts are set out in the nursery, always handle them carefully, to avoid dismantling of graft union leading to death of graft.

Propagation through Specialized Organs

Runners: The most widely known example of propagation of plants with runner division is the strawberry. Generally one plant produces 7–10 runners per plant but

Mass multiplication of a strawberry through runners

under proper management, it can go up to 15 runners per plant. After fruiting, the strawberry begins to produce several runners. Wherever the runner has contact with the surface, it will root and form a new plant. After cutting off the new plant from the mother plant, we can transplant it before the cold season begins. The new plant will then produce fruits with its highest potential yield in the next year.

Suckers: In banana, sword and maiden suckers are generally considered the most reliable and productive planting material. The suckers are 0.5–1.0 m long, with a cone-shaped growing stem and small narrowly expanded leaves. After extraction with hand tools, suckers or corm pieces must be subjected to plant protection treatment to minimize the transfer of pests and diseases, and then planted directly into a new field.

Cuttings: This method is commonly used in plants, which root easily and readily, thus multiplication of plants is very quick and cheap. The shoots of about one year old or more can easily be used for preparing hard wood cuttings. In case of deciduous plants, the cuttings are made after pruning. However, in evergreen fruit plants, the cuttings are made during spring and rainy season. Generally the cuttings of 15–20 cm length and having 3–5 buds are preferred.

Multiplication through cutting

Standards for Planting Material of Fruit Crops

Standards for Planting Material of Fruit Crops

1. Almond

A. Wedge Grafting

Sl. No.	Parameters	Standards
1	Method of propagation	Wedge grafting
2	Type of rootstock	Vigorous
3	Raising rootstock	In polyethylene bag
4	Size of polyethylene bag	20 x 18 cm
5	Age of rootstock	8 to 10 months
6	Diameter of the rootstock/scion	0.7 to 1.5 cm
7	Age of scion wood	6 to 8 months
8	Length of scion wood	10 to 15 cm
9	Length of vertical cut on rootstock	2.0 to 2.5 cm
10	Length of slanting cut on both the sides at lower end of scion	2.0 to 2.5 cm
11	No. of buds/scion wood	3 to 4
12	Grafting height	15 to 20 cm above the soil surface or polybag
13	Time of grafting	February to March

B. T-Budding

Sl. No.	Parameters	Standards
1	Method of propagation	T-budding
2	Type of rootstock	Vigorous
3	Raising rootstock	In polyethylene bag
4	Size of polyethylene bag	20 x 18 cm
5	Age of rootstock	10 to 12 months old
6	Diameter of rootstock/scion	0.8 to 1.25 cm
7	Age of scion shoots	7 to 8 months
8	Length of bud wood	1.25 to 1.5 cm
9	Length of cut on the rootstock for inserting bud on T-point	1.25 to 1.5 cm
10	Budding height	15 to 20 cm above soil surface or poly bag
11	Time of budding	July to September

2. Aonla

A. Wedge Grafting

Sl. No.	Parameters	Standards
1	Method of grafting	Wedge grafting
2	Raising rootstock	In polyethylene bag
3	Size of polyethylene bag	20 x 18 cm
4	Type of rootstock	Straight and active growth stage
5	Age of rootstock	7 to 9 months
6	Diameter of rootstock/scion	0.5 to 0.8 cm
7	Age of scion	3 to 4 months
8	Length of scion	15 to 18 cm
9	No. of buds on the scion stick	6 to 8
10	Length of vertical cut on rootstock	4.0 to 4.5 cm
11	Length of slanting cut on both the sides at lower end of scion	4.0 to 4.5 cm
12	Grafting height	15 to 20 cm above soil surface or poly bag
13	Time of grafting	Greenhouse – January to April and October to December Open field – January to April and October to December

B. Patch Budding

Sl. No.	Parameters	Standards
1	Method of propagation	Patch/Modified Ring budding
2	Type of rootstock	Seedling rootstock having straight growth without side shoots
3	Raising rootstock	In polyethylene bag
4	Size of polyethylene bag	20 x 18 cm
5	Age of rootstock	7 to 9 months
6	Diameter of rootstock/scion	0.8 to 1.0 cm
7	Age of scion shoots	2 to 3 months
8	Bud size	1.5 x 2.5 cm
9	Budding height	15 to 20 cm above soil surface or poly bag
10	Time of budding	Greenhouse – September to February Open field conditions – May to September

3. Apple

A. Wedge Grafting

Sl. No.	Parameters	Standards
1	Method of propagation	Wedge grafting
2	Type of rootstock	Vigorous
3	Raising rootstock	In polyethylene bag
4	Size of polyethylene bag	20 x 18 cm
5	Age of rootstock	12 to 15 months
6	Diameter of the rootstock/scion	0.7 to 1.5 cm
7	Age of scion wood	8 to 10 months
8	Length of scion wood	10 to 15 cm
9	No. of buds/scion wood	3 to 4
10	Length of vertical cut on rootstock	1.0 to 1.5 cm
11	Length of slanting cut on both the sides at lower end of scion	1.0 to 1.5 cm
12	Grafting height	15 to 20 cm above the soil surface or poly bag
13	Time of grafting	February to March

B. Tongue Grafting

Sl. No.	Parameters	Standards
1	Method of propagation	Tongue grafting
2	Type of rootstock	Vigorous
3	Raising rootstock	In polyethylene bag
4	Size of polyethylene bag	20 x 18 cm
5	Age of rootstock	12 to 15 months
6	Diameter of the rootstock	1 to 1.5 cm
7	No. of buds/scion wood	2 to 4
8	Length of scion wood	10 to 15 cm
9	Length of one side slant cut at lower end of scion	1.25 to 1.5 cm
10	Length of one side slant cut on top of the rootstock	1.25 to 1.5 cm
11	Age of scion wood	7 to 8 months
12	Grafting height	Clonal rootstock – 25 to 30 cm Seedling rootstock – 4 to 6 cm
13	Time of grafting	February to March

C. T-Budding



Sl. No.	Parameters	Standards
1	Method of propagation	T-budding
2	Type of rootstock	Vigorous
3	Raising rootstock	In polyethylene bag
4	Size of polyethylene bag	20 x 18 cm
5	Age of rootstock	10 to 12 months old
6	Diameter of rootstock/scion	0.8 to 1.25 cm
7	Age of scion shoots	7 to 8 months
8	Length of bud wood	1.25 to 1.5 cm
9	Length of cut on the rootstock for inserting bud on T-point	1.25 to 1.5 cm
10	Budding height	15 to 20 cm above soil surface or poly bag
11	Time of budding	July to August

4. Apricot

A. Wedge Grafting

Sl. No.	Parameters	Standards
1	Method of propagation	Wedge grafting
2	Type of rootstock	Vigorous
3	Raising rootstock	In polyethylene bag
4	Size of polyethylene bag	20 x 18 cm
5	Age of rootstock	12 to 15 months
6	Diameter of the rootstock/scion	0.7 to 1.0 cm
7	Age of scion wood	8 to 10 months
8	Length of scion wood	10 to 15 cm
9	Length of vertical cut on rootstock	1.25 to 1.5 cm
10	Length of slanting cut on both the sides at lower end of scion	1.25 to 1.5 cm
11	No. of buds/scion wood	3 to 4 nos
12	Grafting height	15 to 20 cm above the soil surface or poly bag
13	Time of grafting	February to March

B. T-Budding

Sl. No.	Parameters	Standards
1	Method of propagation	T-budding
2	Type of rootstock	Vigorous
3	Raising rootstock	In polyethylene bag
4	Size of polyethylene bag	20 x 18 cm
5	Age of rootstock	12 to 15 months
6	Diameter of rootstock/scion	0.7 to 1.0 cm
7	Age of scion shoots	7 to 8 months
8	Length of bud wood	1.25 to 1.5 cm
9	Length of cut on the rootstock for inserting bud on T-point	1.25 to 1.5 cm
10	Budding height	15 to 20 cm above the soil surface or poly bag
11	Time of budding	July to August

5. Avocado

A. Wedge Grafting

Sl. No.	Parameters	Standards
1	Method of grafting	Wedge grafting
2	Type of rootstock	Straight and active growth stage
3	Raising rootstock	In polyethylene bag
4	Size of polyethylene bag	15 x 18 cm
5	Age of rootstock	6 to 8 months
6	Diameter of rootstock/scion	0.5 to 1.0 cm
7	Age of scion stick	3 to 4 months
8	Length of scion sticks	12 to 15 cm
9	Length of vertical cut on rootstock	3.0 to 3.5 cm
10	Length of slanting cut on both the sides at lower end of scion	3.0 to 3.5 cm
11	No. of buds/scion wood	2.0 to 3.0
12	Grafting height	15 to 20 cm above the soil surface or poly bag
13	Time of grafting	January to December in greenhouse as well as in open field condition

B. T-Budding

Sl. No.	Parameters	Standards
1	Method of propagation	T-budding
2	Type of rootstock	Vigorous
3	Raising rootstock	In polyethylene bag
4	Size of polyethylene bag	20 x 18 cm
5	Age of rootstock	9 to 10 months
6	Diameter of rootstock/scion	0.7 to 0.9 cm
7	Age of scion shoots	5 to 6 months
8	Length of bud wood	2.0 to 2.5 cm
9	Length of cut on the rootstock for inserting bud on T-point	2.0 to 2.5 cm
10	Budding height	15 to 20 cm above the soil surface or poly bag
11	Time of budding	February to March

6. Bael

Wedge Grafting

Sl. No.	Parameters	Standards
1	Method of propagation	Wedge grafting
2	Type of rootstock	Vigorous
3	Raising rootstock	In polyethylene bag
4	Size of polyethylene bag	18 x 20 cm
5	Age of rootstock	10 to 12 months
6	Diameter of rootstock/scion	0.8 to 1.25 cm
7	Age of scion shoots	5 to 6 months
8	Length of scion	12 to 15 cm
9	Length of vertical cut on rootstock	3.5 to 4.0 cm
10	Length of slanting cut on both the sides at lower end of scion	3.5 to 4.0 cm
11	No. of buds/scion	4.0 to 5.0
12	Grafting height	15 to 20 cm above the soil surface or poly bag
13	Time of grafting	Greenhouse – September, October and April Open field conditions – April and May

7. Banana

Suckers

Sl. No.	Parameters	Standards
1	Method of propagation	Sword suckers
2	Age of sucker	Not less than 3 months
3	Weight of sucker	Not less than 1 kg
4	Suckers selections	• Select and mark plants of the desired variety with normal or below average height, a stout trunk and firm roots. Plants should be free of undesirable variations of the varietal characteristics. Selection should be made between flowering time and harvest to mark plants with above average bunch size. • When suckers are selected, whether to be used as planting material or as starting material in tissue culture multiplication techniques, document their origins (state, village, farmer) and identify and describe the plot they come from. If the suckers are used in tissue culture, the source of shoot tips should be specified as monoclonal (originating from a single mother plant) or polyclonal (originating from more than one mother plant). • Good suckers are cone shaped and do not develop broad leaves until they are more than 1 m high
5	Size of suckers	Atleast 20 cm in diameter

8. Cashew

Soft Wood Grafting

Sl. No.	Parameters	Standards
1	Method of propagation	Soft wood grafting
2	Type of rootstock	Vigorous
3	Raising rootstock	In polyethylene bag
4	Size of polyethylene bag	18 x 20 cm
5	Age of rootstock	2 to 4 months
6	Diameter of rootstock/scion	0.5 to 0.7 cm
7	Age of scion shoots	3 to 4 months
8	Length of scion	12 to 15 cm
9	Length of vertical cut on rootstock	2.5 to 3.0 cm
10	Length of slanting cut on both the sides at lower end of scion	2.5 to 3.0 cm
11	No. of buds/scion	3.0 to 4.0
12	Grafting height	20 to 25 cm above the soil surface or poly bag
13	Time of grafting	June to November

9. Cherry

A. Wedge Grafting

Sl. No.	Parameters	Standards
1	Method of propagation	Wedge grafting
2	Type of rootstock	Vigorous
3	Raising rootstock	In polyethylene bag
4	Size of polyethylene bag	18 x 20 cm
5	Age of rootstock	12 to 15 months
6	Diameter of rootstock/scion	1.0 to 1.5 cm
7	Age of scion shoots	10 to 12 months
8	Length of scion	12 to 15 cm
9	Length of vertical cut on rootstock	1.25 to 1.5 cm
10	Length of slanting cut on both the sides at lower end of scion	1.25 to 1.5 cm
11	No. of buds/scion	3.0 to 4.0
12	Grafting height	15 to 20 cm above the soil surface or poly bag
13	Time of grafting	February to March

B. Tongue Grafting

Sl. No.	Parameters	Standards
1	Method of propagation	Tongue grafting
2	Type of rootstock	Vigorous
3	Raising rootstock	In polyethylene bag
4	Size of polyethylene bag	20 x 18 cm
5	Age of rootstock	12 to 15 months
6	Diameter of the rootstock/scion	1 to 1.5 cm
7	No. of buds/scion wood	2 to 4 (dormant bud)
8	Length of scion wood	10 to 15 cm
9	Length of one side slant cut at lower end of scion	1.5 to 2.0 cm
10	Length of one side slant cut on top of the rootstock	1.5 to 2.0 cm
11	Age of scion wood	8 to 9 months
12	Grafting height	20 to 25 cm above the soil surface or poly bag
13	Time of grafting	February to March

10. Citrus

A. Wedge Grafting (Mandarin and Sweet Orange)

Sl. No.	Parameters	Standards
1	Method of propagation	Wedge grafting
2	Type of rootstock	Vigorous
3	Raising rootstock	In polyethylene bag
4	Size of polyethylene bag	18 x 20 cm
5	Age of rootstock	9 to 10 months
6	Diameter of rootstock/scion	0.7 to 0.9 cm
7	Age of scion shoots	4 to 5 months
8	Length of scion	12 to 15 cm
9	Length of vertical cut on rootstock	3.5 to 4.0 cm
10	Length of slanting cut on both the sides at lower end of scion	3.5 to 4.0 cm
11	No. of buds/scion	3.0 to 5.0
12	Grafting height	15 to 20 cm above the soil surface or poly bag
13	Time of grafting	October to March

B. T-Budding (Mandarin, Sweet Orange, Lime and Lemon)

Sl. No.	Parameters	Standards
1	Method of propagation	T-budding
2	Type of rootstock	Vigorous
3	Raising rootstock	In polyethylene bag
4	Size of polyethylene bag	20 x 18 cm
5	Age of rootstock	9 to 10 months
6	Diameter of rootstock/scion	0.7 to 0.9 cm
7	Age of scion shoots	5 to 6 months
8	Length of bud wood	2.0 to 2.5 cm
9	Length of cut on the rootstock for inserting bud on T-point	2.0 to 2.5 cm
10	Budding height	15 to 20 cm above the soil surface or poly bag
11	Time of budding	February to March and September to October

C. Cutting (Lime and Lemon)

Sl. No.	Parameters	Standards
1	Method of propagation	Cutting
2	Age of plant	Not less than 6 months
3	Stem diameter	Not less than 0.5 cm
4	Plant height	Not less than 40 cm, straight and single stem
5	No. of roots	Not less than 10 fibrous roots
6	Foliage	Healthy and green straight with single stem without side shoots
7	Disease and pest incidence	Free from any diseases and pests

11. Custard Apple

Wedge Grafting

Sl. No.	Parameters	Standards
1	Method of propagation	Wedge grafting
2	Type of rootstock	Vigorous
3	Raising rootstock	In polyethylene bag
4	Size of polyethylene bag	18 x 20 cm
5	Age of rootstock	10 to 12 months
6	Diameter of rootstock/scion	1.5 to 2.5 cm
7	Age of scion shoots	6 to 7 months
8	Length of scion	12 to 15 cm
9	Length of vertical cut on rootstock	3.5 to 4.0 cm
10	Length of slanting cut on both the sides at lower end of scion	3.5 to 4.0 cm
11	No. of buds/scion	3.0 to 4.0
12	Grafting height	15 to 20 cm above the soil surface or poly bag
13	Time of grafting	December to March

12. Date Palm

Suckers

Sl. No.	Parameters	Standards
1	Method of propagation	Off shoots (Suckers)
2	Age of sucker	18 to 20 months
3	Weight of sucker	8 to 15 kg
4	Separation of suckers from mother plants	4 to 5 years after planting. Prior to the removal of suckers, the outer leaves are cut back to 2/3rd of their length and the inner leaves to ½

13. Fig

Cutting

Sl. No.	Parameters	Standards
1	Method of propagation	Hard/semi hard wood cutting
2	Mother tree	An elite mother tree, free from diseases, productivity large sized quality fruits. Cutting should be slant cut at the base
3	Raising cutting	In polyethylene bag
4	Size of polyethylene	18 x 20 cm
5	Time of cutting	June to September
6	Diameter of wood	1.25 to 2.0 cm
7	Length of wood	15 to 25 cm
8	No. of nodes/wood	3 to 6

14. Grape

A. Wedge Grafting

Sl. No.	Parameters	Standards
1	Method of propagation	Wedge grafting
2	Type of rootstock	Vigorous
3	Raising rootstock	In polyethylene bag
4	Size of polyethylene bag	18 x 20 cm
5	Age of rootstock	6 to 8 months
6	Diameter of rootstock/scion	0.7 to 0.9 cm
7	Age of scion shoots	5 to 6 months
8	Length of scion	15 to 20 cm
9	Length of vertical cut on rootstock	3.5 to 4.0 cm
10	Length of slanting cut on both the sides at lower end of scion	3.5 to 4.0 cm
11	No. of buds/scion	3.0 to 5.0
12	Grafting height	15 to 20 cm above the soil surface or poly bag
13	Time of grafting	August to September

B. Cutting

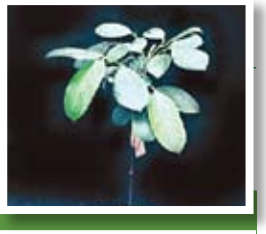
Sl. No.	Parameters	Standards
1	Method of propagation	Hard wood cutting. Basal cut just below the lower bud and the upper cut 2 to 5 cm above the top bud. Do not make more than two cutting from a cane and the cutting should be slant cut at the top
2	Mother tree	An elite mother tree, free from diseases, productivity large sized quality berries (fruits)
3	Raising cutting	In polyethylene bag
4	Size of polyethylene	18 x 20 cm
5	Time of cutting	March to April and October
6	Diameter of cane	1 to 1.5 cm
7	Length of cane	15 to 20 cm
8	No. of bud/cane	4 to 6

15. Guava

Wedge Grafting

Sl. No.	Parameters	Standards
1	Method of propagation	Wedge grafting
2	Type of rootstock	Vigorous
3	Raising rootstock	In polyethylene bag
4	Size of polyethylene bag	18 x 20 cm
5	Age of rootstock	8 to 9 months
6	Diameter of rootstock/scion	0.5 to 1.0 cm
7	Age of scion shoots	3 to 4 months
8	Length of scion	12 to 15 cm
9	Length of vertical cut on rootstock	4.0 to 4.5 cm
10	Length of slanting cut on both the sides at lower end of scion	4.0 to 4.5 cm
11	No. of buds/scion	3.0 to 4.0
12	Grafting height	15 to 20 cm above the soil surface or poly bag
13	Time of grafting	January to December

16. Jack Fruit



A. Soft Wood Grafting

Sl. No.	Parameters	Standards
1	Method of propagation	Soft wood grafting
2	Type of rootstock	Vigorous
3	Raising rootstock	In polyethylene bag
4	Size of polyethylene bag	18 x 20 cm
5	Age of rootstock	8 to 10 months
6	Diameter of rootstock/scion	0.7 to 0.9 cm
7	Age of scion shoots	3 to 5 months
8	Length of scion	8 to 10 cm
9	Length of vertical cut on rootstock	4.0 to 5.0 cm
10	Length of slanting cut on both the sides at lower end of scion	4.0 to 5.0 cm
11	No. of buds/scion	3.0 to 4.0
12	Grafting height	20 to 25 cm above the soil surface or poly bag
13	Time of grafting	July to September

B. Patch Budding

Sl. No.	Parameters	Standards
1	Method of propagation	Patch budding
2	Type of rootstock	Seedling rootstock having straight growth without side shoots
3	Raising rootstock	In polyethylene bag
4	Size of polyethylene bag	20 x 18 cm
5	Age of rootstock	5 to 7 months
6	Diameter of rootstock/scion	0.8 to 1.25 cm
7	Age of scion shoots	2 to 3 months
8	Bud size	1.0 x 3.0 cm
9	Budding height	15 to 20 cm above soil surface or poly bag
10	Time of budding	May to September

17. Jamun

Soft Wood Grafting

Sl. No.	Parameters	Standards
1	Method of propagation	Soft wood grafting
2	Type of rootstock	Vigorous
3	Raising rootstock	In polyethylene bag
4	Size of polyethylene bag	18 x 20 cm
5	Age of rootstock	8 to 10 months
6	Diameter of rootstock/scion	0.8 to 1.5 cm
7	Age of scion shoots	6 to 8 months
8	Length of scion	12 to 15 cm
9	Length of vertical cut on rootstock	3.5 to 4.0 cm
10	Length of slanting cut on both the sides at lower end of scion	3.5 to 4.0 cm
11	No. of buds/scion	3.0 to 4.0
12	Grafting height	20 to 25 cm above the soil surface or poly bag
13	Time of grafting	February to March and July to September

18. Khirnee

Soft Wood Grafting

Sl. No.	Parameters	Standards
1	Method of propagation	Soft wood grafting
2	Type of rootstock	Vigorous
3	Raising rootstock	In polyethylene bag
4	Size of polyethylene bag	18 x 20 cm
5	Age of rootstock	10 to 12 months
6	Diameter of rootstock/scion	0.8 to 1.5 cm
7	Age of scion shoots	6 to 7 months
8	Length of scion	12 to 15 cm
9	Length of vertical cut on rootstock	3.5 to 4.0 cm
10	Length of slanting cut on both the sides at lower end of scion	3.5 to 4.0 cm
11	No. of buds/scion	3.0 to 4.0
12	Grafting height	20 to 25 cm above the soil surface or poly bag
13	Time of grafting	August to September

19. Kiwi

A. Cutting

Sl. No.	Parameters	Standards
1	Method of propagation	Hard and semi-hard wood cutting. Well mature dormant shoot should be used for cutting. Tips of the shoot should be avoided
2	Mother tree	An elite mother tree, free from diseases, productivity large sized quality berries (fruits)
3	Raising cutting	In polyethylene bag
4	Size of polyethylene	18 x 20 cm
5	Time of cutting	January to February for hard wood cutting and July to August for semi-hard wood cutting. The cuttings of central and basal parts are ideal
6	Diameter of wood	0.5 to 1.0 cm
7	Length of wood	15 to 25 cm
8	No. of bud/cutting	3 to 5

B. T-Budding

Sl. No.	Parameters	Standards
1	Method of propagation	T-budding
2	Type of rootstock	Vigorous
3	Raising rootstock	In polyethylene bag
4	Size of polyethylene bag	20 x 18 cm
5	Age of rootstock	9 to 10 months
6	Diameter of rootstock/scion	0.7 to 0.9 cm
7	Age of scion shoots	5 to 6 months
8	Length of bud wood	2.0 to 2.5 cm
9	Length of cut on the rootstock for inserting bud on T-point	2.0 to 2.5 cm
10	Budding height	10 to 15 cm above the soil surface or poly bag
11	Time of budding	February to March

20. Litchi

A. Wedge Grafting

Sl. No.	Parameters	Standards
1	Method of propagation	Wedge grafting
2	Type of rootstock	Vigorous
3	Raising rootstock	In polyethylene bag
4	Size of polyethylene bag	18 x 20 cm
5	Age of rootstock	9 to 12 months
6	Diameter of rootstock/scion	0.5 to 1.0 cm
7	Age of scion shoots	2 to 3 months
8	Length of scion	15 to 18 cm
9	Length of vertical cut on rootstock	3.5 to 4.0 cm
10	Length of slanting cut on both the sides at lower end of scion	3.5 to 4.0 cm
11	No. of buds/scion	3.0 to 4.0
12	Grafting height	10 to 15 cm above the soil surface or poly bag
13	Time of grafting	Greenhouse – Round the year Shednet house – July to September and January to March

B. Air Layering

Sl. No.	Parameters	Standards
1	Method of propagation	Air layering
2	Age of scion shoots	10 to 12 months
3	Diameter of scion	1 to 1.25 cm
4	Length of shoot	25 to 35 cm
5	Age of the rooted cutting	2 to 3 months from date of air-layering and planting in the nursery bed
6	Height of the air layered plant	30 to 45 cm
7	Diameter of the air layered plants	1.5 to 2.0 cm
8	Growth of plants	Vigorous with dark green leaves
9	Root system	Well developed
10	Condition of the earth ball	Intact and moist

21. Mahua

Soft Wood Grafting

Sl. No.	Parameters	Standards
1	Method of propagation	Soft wood grafting
2	Type of rootstock	Vigorous
3	Raising rootstock	In polyethylene bag
4	Size of polyethylene bag	18 x 20 cm
5	Age of rootstock	10 to 12 months
6	Diameter of rootstock/scion	0.8 to 1.5 cm
7	Age of scion shoots	6 to 7 months
8	Length of scion	12 to 15 cm
9	Length of vertical cut on rootstock	3.5 to 4.0 cm
10	Length of slanting cut on both the sides at lower end of scion	3.5 to 4.0 cm
11	No. of buds/scion	3.0 to 4.0
12	Grafting height	20 to 25 cm above the soil surface or poly bag
13	Time of grafting	August to September

22. Mango

A. Wedge Grafting

Sl. No.	Parameters	Standards
1	Method of propagation	Wedge grafting
2	Type of rootstock	Vigorous
3	Raising rootstock	In polyethylene bag
4	Size of polyethylene bag	18 x 20 cm
5	Age of rootstock	9 to 10 months
6	Diameter of rootstock/scion	0.8 to 1.5 cm
7	Age of scion shoots	4 to 5 months
8	Length of scion	15 to 18 cm
9	Length of vertical cut on rootstock	4.0 to 4.5 cm
10	Length of slanting cut on both the sides at lower end of scion	4.0 to 4.5 cm
11	No. of buds/scion	3.0 to 4.0
12	Grafting height	15 to 20 cm above the soil surface or poly bag
13	Time of grafting	January to December

B. Soft Wood Grafting

Sl. No.	Parameters	Standards
1	Method of propagation	Soft wood grafting
2	Type of rootstock	Vigorous
3	Raising rootstock	In polyethylene bag
4	Size of polyethylene bag	18 x 20 cm
5	Age of rootstock	9 to 10 months
6	Diameter of rootstock/scion	0.8 to 1.5 cm
7	Age of scion shoots	4 to 5 months
8	Length of scion	15 to 18 cm
9	Length of vertical cut on rootstock	3.5 to 4.0 cm
10	Length of slanting cut on both the sides at lower end of scion	3.5 to 4.0 cm
11	No. of buds/scion	3.0 to 4.0
12	Grafting height	20 to 25 cm above the soil surface or poly bag
13	Time of grafting	Greenhouse – January to December Open field condition – July to September

C. Veneer Grafting

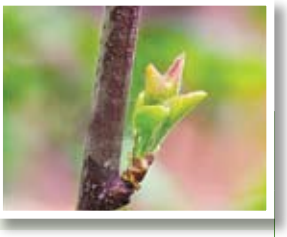
Sl. No.	Parameters	Standards
1	Method of propagation	Veneer grafting
2	Type of rootstock	Vigorous
3	Raising rootstock	In polyethylene bag
4	Size of polyethylene bag	18 x 20 cm
5	Age of rootstock	9 to 10 months
6	Diameter of rootstock/scion	0.8 to 1.5 cm
7	Age of scion shoots	4 to 5 months
8	Length of scion	15 to 18 cm
9	Length of one side cut on rootstock	4.0 to 4.5 cm
10	Length of one side slant cut at lower end of scion	4.0 to 4.5 cm
11	No. of buds/scion	3.0 to 4.0
12	Grafting height	15 to 20 cm above the soil surface or poly bag
13	Time of grafting	Greenhouse – January to December Open field condition – July to September

23. Peach

A. Wedge Grafting

Sl. No.	Parameters	Standards
1	Method of propagation	Wedge grafting
2	Type of rootstock	Vigorous
3	Raising rootstock	In polyethylene bag
4	Size of polyethylene bag	18 x 20 cm
5	Age of rootstock	12 to 15 months
6	Diameter of rootstock/scion	1.0 to 1.5 cm
7	Age of scion shoots	8 to 10 months
8	Length of scion	12 to 15 cm
9	Length of vertical cut on rootstock	1.0 to 1.5 cm
10	Length of slanting cut on both the sides at lower end of scion	1.0 to 1.5 cm
11	No. of buds/scion	3.0 to 4.0
12	Grafting height	15 to 20 cm above the soil surface or poly bag
13	Time of grafting	February to March

B. T-Budding



Sl. No.	Parameters	Standards
1	Method of propagation	T-budding
2	Type of rootstock	Vigorous
3	Raising rootstock	In polyethylene bag
4	Size of polyethylene bag	20 x 18 cm
5	Age of rootstock	9 to 10 months
6	Diameter of rootstock/scion	0.7 to 0.9 cm
7	Age of scion shoots	5 to 6 months
8	Length of bud wood	2.0 to 2.5 cm
9	Length of cut on the rootstock for inserting bud on T-point	2.0 to 2.5 cm
10	Budding height	15 to 20 cm above the soil surface or poly bag
11	Time of budding	May to June

C. Tongue Grafting

Sl. No.	Parameters	Standards
1	Method of propagation	Tongue grafting
2	Type of rootstock	Vigorous
3	Raising rootstock	In polyethylene bag
4	Size of polyethylene bag	20 x 18 cm
5	Age of rootstock	12 to 15 months
6	Diameter of the rootstock/scion	1.0 to 1.5 cm
7	No. of buds/scion wood	2 to 4 (dormant bud)
8	Length of scion wood	10 to 15 cm
9	Length of one side slant cut at lower end of scion	2.5 to 3.0 cm
10	Length of one side slant cut on top of the rootstock	2.5 to 3.0 cm
11	Age of scion wood	6 to 8 months
12	Grafting height	20 to 25 cm above the soil surface or poly bag
13	Time of grafting	January to February

24. Pear

A. Wedge Grafting

Sl. No.	Parameters	Standards
1	Method of propagation	Wedge grafting
2	Type of rootstock	Vigorous
3	Raising rootstock	In polyethylene bag
4	Size of polyethylene bag	18 x 20 cm
5	Age of rootstock	12 to 15 months
6	Diameter of rootstock/scion	0.7 to 1.5 cm
7	Age of scion shoots	8 to 10 months
8	Length of scion	12 to 15 cm
9	Length of vertical cut on rootstock	2.5 to 3.0 cm
10	Length of slanting cut on both the sides at lower end of scion	2.5 to 3.0 cm
11	No. of buds/scion	3.0 to 4.0
12	Grafting height	15 to 20 cm above the soil surface or poly bag
13	Time of grafting	February to March

B. Tongue Grafting

Sl. No.	Parameters	Standards
1	Method of propagation	Tongue grafting
2	Type of rootstock	Vigorous
3	Raising rootstock	In polyethylene bag
4	Size of polyethylene bag	20 x 18 cm
5	Age of rootstock	12 to 15 months
6	Diameter of the rootstock/scion	1.0 to 1.5 cm
7	No. of buds/scion wood	2 to 4 (dormant bud)
8	Length of scion wood	10 to 15 cm
9	Length of one side slant cut at lower end of scion	2.5 to 3.0 cm
10	Length of one side slant cut on top of the rootstock	2.5 to 3.0 cm
11	Age of scion wood	6 to 8 months
12	Grafting height	20 to 25 cm above the soil surface or poly bag
13	Time of grafting	December to January

C. T-Budding

Sl. No.	Parameters	Standards
1	Method of propagation	T-budding
2	Type of rootstock	Vigorous
3	Raising rootstock	In polyethylene bag
4	Size of polyethylene bag	20 x 18 cm
5	Age of rootstock	12 to 15 months
6	Diameter of rootstock/scion	1.0 to 1.5 cm
7	Age of scion shoots	6 to 8 months
8	Length of bud wood	2.5 to 3.0 cm
9	Length of cut on the rootstock for inserting bud on T-point	2.5 to 3.0 cm
10	Budding height	15 to 20 cm above the soil surface or poly bag
11	Time of budding	April to September

25. Pecan Nut

A. Patch Budding

Sl. No.	Parameters	Standards
1	Method of propagation	Patch/Modified Ring budding
2	Type of rootstock	Seedling rootstock having straight growth without side shoots
3	Raising rootstock	In polyethylene bag
4	Size of polyethylene bag	20 x 18 cm
5	Age of rootstock	18 to 20 months
6	Diameter of rootstock	2.0 to 3.0 cm
7	Age of scion shoots	10 to 12 months
8	Bud size	1.0 x 3.0 cm
9	Budding height	20 to 25 cm above soil surface or poly bag
10	Time of budding	May to June

B. Wedge Grafting

Sl. No.	Parameters	Standards
1	Method of propagation	Wedge grafting
2	Type of rootstock	Vigorous
3	Raising rootstock	In polyethylene bag
4	Size of polyethylene bag	18 x 20 cm
5	Age of rootstock	15 to 20 months
6	Diameter of rootstock/scion	3.5 to 4.5 cm
7	Age of scion shoots	8 to 10 months
8	Length of scion	12 to 15 cm
9	Length of vertical cut on rootstock	3.0 to 3.5 cm
10	Length of slanting cut on both the sides at lower end of scion	3.0 to 3.5 cm
11	No. of buds/scion	3.0 to 4.0
12	Grafting height	15 to 20 cm above the soil surface or poly bag
13	Time of grafting	February to March

26. Pineapple

Suckers

Sl. No.	Parameters	Standards
1	Method of propagation	Suckers and slips
2	Age of sucker/slip	Not less than 3 months
3	Weight of sucker	450 to 750 g
4	Weight of the slip	350 to 500 g

27. Plum

A. Wedge Grafting

Sl. No.	Parameters	Standards
1	Method of propagation	Wedge grafting
2	Type of rootstock	Vigorous
3	Raising rootstock	In polyethylene bag
4	Size of polyethylene bag	18 x 20 cm
5	Age of rootstock	12 to 15 months
6	Diameter of rootstock/scion	0.7 to 1.5 cm
7	Age of scion shoots	8 to 10 months
8	Length of scion	12 to 15 cm
9	Length of vertical cut on rootstock	2.5 to 3.0 cm
10	Length of slanting cut on both the sides at lower end of scion	2.5 to 3.0 cm
11	No. of buds/scion	3.0 to 4.0
12	Grafting height	15 to 20 cm above the soil surface or poly bag
13	Time of grafting	February to March

B. Tongue Grafting

Sl. No.	Parameters	Standards
1	Method of propagation	Tongue grafting
2	Type of rootstock	Vigorous
3	Raising rootstock	In polyethylene bag
4	Size of polyethylene bag	20 x 18 cm
5	Age of rootstock	12 to 15 months
6	Diameter of the rootstock/scion	1.0 to 1.5 cm
7	No. of buds/scion wood	2 to 4 (dormant bud)
8	Length of scion wood	10 to 15 cm
9	Length of one side slant cut at lower end of scion	2.5 to 3.0 cm
10	Length of one side slant cut on top of the rootstock	2.5 to 3.0 cm
11	Age of scion wood	6 to 8 months
12	Grafting height	20 to 25 cm above the soil surface or poly bag
13	Time of grafting	February

C. T-Budding

Sl. No.	Parameters	Standards
1	Method of propagation	T-budding
2	Type of rootstock	Vigorous
3	Raising rootstock	In polyethylene bag
4	Size of polyethylene bag	20 x 18 cm
5	Age of rootstock	12 to 15 months
6	Diameter of rootstock/scion	0.7 to 1.0 cm
7	Age of scion shoots	7 to 8 months
8	Length of bud wood	1.25 to 1.5 cm
9	Length of cut on the rootstock for inserting bud on T-point	1.25 to 1.5 cm
10	Budding height	15 to 20 cm above the soil surface or poly bag
11	Time of budding	July to August

28. Pomegranate

A. Wedge Grafting

Sl. No.	Parameters	Standards
1	Method of propagation	Wedge grafting
2	Type of rootstock	Vigorous
3	Raising rootstock	In polyethylene bag
4	Size of polyethylene bag	18 x 20 cm
5	Age of rootstock	8 to 10 months
6	Diameter of rootstock/scion	0.6 to 0.8 cm
7	Age of scion shoots	6 to 8 months
8	Length of scion	12 to 15 cm
9	Length of vertical cut on rootstock	4.0 to 4.5 cm
10	Length of slanting cut on both the sides at lower end of scion	4.0 to 4.5 cm
11	No. of buds/scion	3.0 to 4.0
12	Grafting height	15 to 20 cm above the soil surface or poly bag
13	Time of grafting	Greenhouse – Round the year Open field – January to February

B. Air Layering

Sl. No.	Parameters	Standards
1	Method of propagation	Air layering
2	Age of the shoot	Not less than 6 months
3	Girth of the shoot	Not less than 2.5 cm
4	Time of Air Layering	July to August and November to December

29. Sapota

Wedge Grafting

Sl. No.	Parameters	Standards
1	Method of propagation	Wedge grafting
2	Type of rootstock	Vigorous
3	Raising rootstock	In polyethylene bag
4	Size of polyethylene bag	18 x 20 cm
5	Age of rootstock	10 to 12 months
6	Diameter of rootstock/scion	2.0 to 2.5 cm
7	Age of scion shoots	3 to 5 months
8	Length of scion	12 to 15 cm
9	Length of vertical cut on rootstock	4.0 to 4.5 cm
10	Length of slanting cut on both the sides at lower end of scion	4.0 to 4.5 cm
11	No. of buds/scion	3.0 to 4.0
12	Grafting height	15 to 20 cm above the soil surface or poly bag
13	Time of grafting	September to October

30. Walnut

A. Wedge Grafting

Sl. No.	Parameters	Standards
1	Method of propagation	Wedge grafting
2	Type of rootstock	Vigorous
3	Raising rootstock	In polyethylene bag
4	Size of polyethylene bag	18 x 20 cm
5	Age of rootstock	12 to 15 months
6	Diameter of rootstock/scion	1.5 to 2.0 cm
7	Age of scion shoots	8 to 10 months
8	Length of scion	12 to 15 cm
9	Length of vertical cut on rootstock	4.0 to 4.5 cm
10	Length of slanting cut on both the sides at lower end of scion	4.0 to 4.5 cm
11	No. of buds/scion	3.0 to 4.0
12	Grafting height	15 to 20 cm above the soil surface or poly bag
13	Time of grafting	February to March

B. Patch Budding

Sl. No.	Parameters	Standards
1	Method of propagation	Patch/Modified Ring budding
2	Type of rootstock	Seedling rootstock having straight growth without side shoots
3	Raising rootstock	In polyethylene bag
4	Size of polyethylene bag	20 x 18 cm
5	Age of rootstock	12 to 15 months
6	Diameter of rootstock	0.8 to 1.25 cm
7	Age of scion shoots	2 to 3 months
8	Bud size	1.0 x 3.0 cm
9	Budding height	20 to 25 cm above soil surface or poly bag
10	Time of budding	July to August

31. Wood Apple

Soft Wood Grafting

Sl. No.	Parameters	Standards
1	Method of propagation	Soft wood grafting
2	Type of rootstock	Vigorous
3	Raising rootstock	In polyethylene bag
4	Size of polyethylene bag	18 x 20 cm
5	Age of rootstock	10 to 12 months
6	Diameter of rootstock/scion	0.8 to 1.5 cm
7	Age of scion shoots	6 to 7 months
8	Length of scion	12 to 15 cm
9	Length of vertical cut on rootstock	3.5 to 4.0 cm
10	Length of slanting cut on both the sides at lower end of scion	3.5 to 4.0 cm
11	No. of buds/scion	3.0 to 4.0
12	Grafting height	20 to 25 cm above the soil surface or poly bag
13	Time of grafting	July to August

Guidelines for Labeling of Planting Material

- Each lot of planting material should be labeled. No sale of planting material should be permitted without proper labeling.
- All the information as per contents of the label for the fruit crop should be mentioned legibly and without any mistakes.
- Self locking labels, which do not get unfastened easily while handling and transport, should preferably be used.
- Labels should be written in Hindi or English or any other local language of the area.
- All the labels for sale of planting material must be signed by the official authorized for the purpose.
- As regards size of label, the label for planting material should be of 12 cm x 6 cm size.

Labels to be Used for Vegetatively Propagated Plants

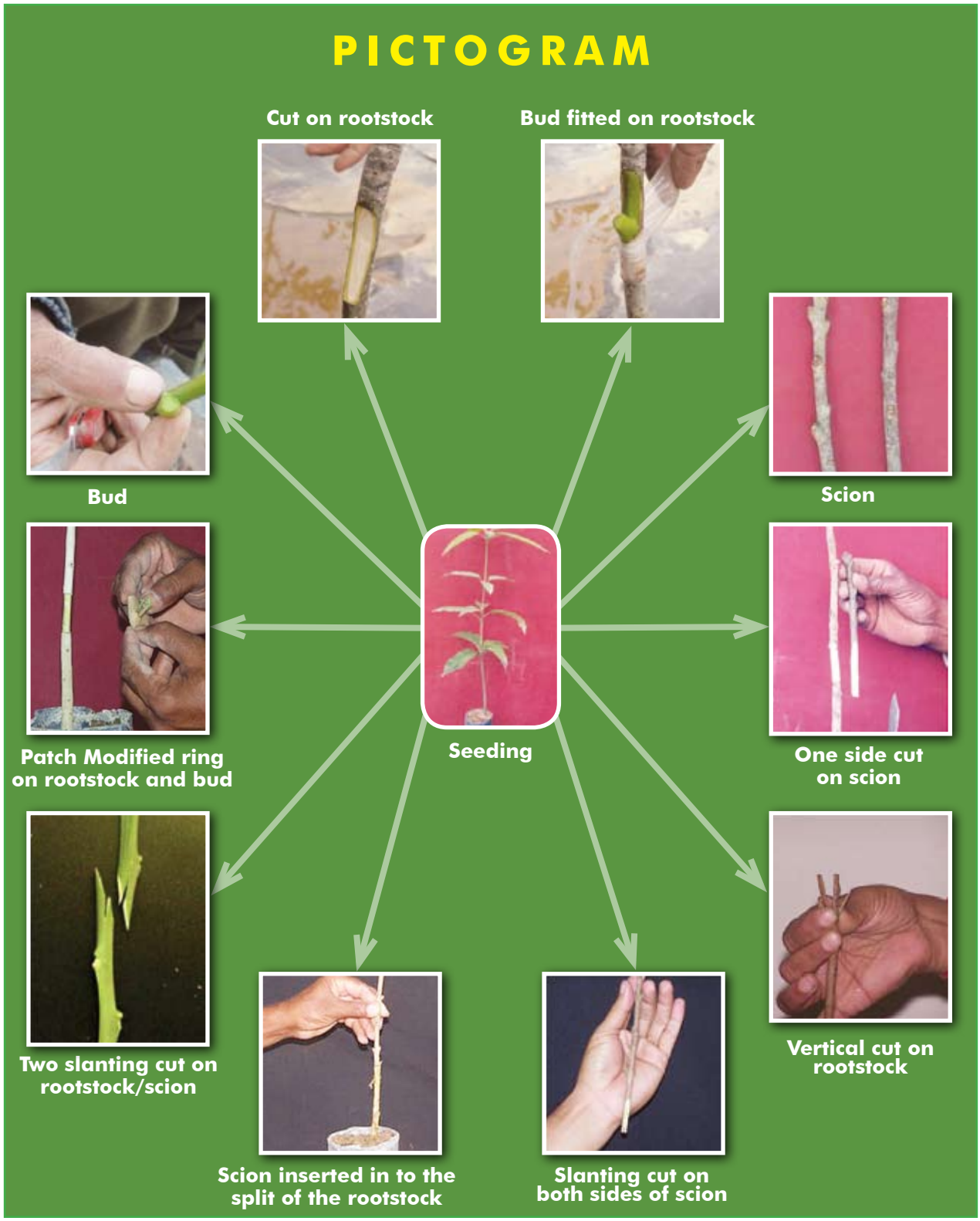
Correct labeling is an important element of responsible and successful nurserymen in distribution of the planting material. The information to be provided on labels varies according to crop and should be correct. In general, these should contain the following details:

Name of the Institution/Nursery/Location
Batch No..... Tag No.....
Crop & variety
Date and age of grafted sapling
Method of propagation
Rootstock
Source of scion or bud wood
Treatment if any and Date of treatment
Freedom from diseases and pests

Glossary of Terms

- **Airlayer:** An undetached shoot portion of a plant on which roots are caused to develop commonly as a result of wounding or other stimulation.
- **Asexual Propagation:** The production of a new plant by any vegetative means, without involving meiosis and the union of gametes.
- **Budding:** A form of grafting in which a single vegetative bud is taken from one plant and inserted into the stem tissue of another, so that the two will grow together. The inserted bud develops into a new shoot.
- **Budstick:** A shoot or twig, used as a source of buds for budding.
- **Callus:** The mass of parenchyma cells that develops from and around wounded plant tissues in order to diminish evaporation from the wound and initiate healing. In grafting it occurs at the junction of a graft union, arriving from living cells of both scion and stock. The production and interlocking of these parenchyma (or cells) cells constitute one of the important steps in the healing process of a successful graft.
- **Cambium:** A thin tissue of the plant located between that bark and the wood. Its cells are meristematic, i.e. they are capable of dividing and forming new cells. For a successful graft union, it is essential that the cambium of the scion in close contact with the cambium of the stock.
- **Cutting:** A detached leaf, stem or root that is encouraged to from new roots and shoots and develop into a new plant.
- **Dormant Period:** Time during which no growth occurs because of unfavorable environment.
- **Dormant Bud:** A bud which has stopped its development for a period due to unfavorable environment (e.g. a dry or cold season). A dormant bud will sprout in response to improve growth conditions or "biological clock" e.g. longer days.
- **Graft Union:** The site of the grafted plant where the scion and the root stock are united.
- **Graftage:** Method of inserting buds, twig or shoots on other stems or roots for fusion of tissues.
- **Grafting:** The connection of two pieces of living plant tissue in such a manner that they will unite and subsequently grow and develop as one plant.
- **Hardening Off:** Adapting plants to outdoor conditions, by withholding water, lowering the temperature or nutrient supply or combination of the above treatments. This conditions the plants for survival when transplanted outdoors.
- **Layering:** Propagation of plants from parts that remain attached to the parent plant while rooting.
- **Nucellus:** A tissue originally making up the major part of the young ovule, in which the embryo sac develops.
- **Rooting Media:** Materials such as sand, peat, perlite, vermiculite or soil, in which the basal ends of cuttings are placed vertically for root development.
- **Scarification (Scarifying):** Injuring or scratching the seed coat to aid germination.
- **Scion:** An aerial plant part, often a branchlet, which is grafted into the root bearing part (stock/root-stock) of another plant.
- **Stock/Root Stock:** The lower portion of the graft, which develops into the root system of the grafted plant. It may be seedling, a rooted cutting or a layered plant.
- **Stratification:** The practice of exposing imbibed seeds to 2 to 10°C (33 to 50°F) for some period before germination to break dormancy. This is a standard practice in germination of many temperate woody species such as apple, pear, peach, etc.

PICTOGRAM


Cut on rootstock
Bud fitted on rootstock
Bud
Scion
Patch Modified ring on rootstock and bud
Seeding
One side cut on scion
Two slanting cut on rootstock/scion
Vertical cut on rootstock
Scion inserted in to the split of the rootstock
Slanting cut on both sides of scion

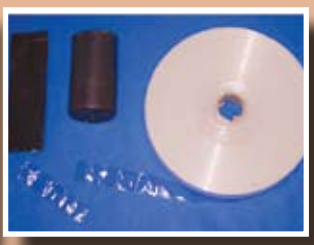
NURSERY
TOOLS AND OTHER MATERIALS

Double blade knife

Lopper

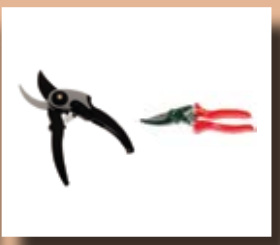
Budding knife

Grafting knife



Poly tube

Pruning saw



Secateurs

Poly bag

Vernier Caliperhoe

Hand hoe

Best tree or Tree of Outstanding Merit (TOM) within each variety be selected, earmarked and used as mother tree for future **multiplication.**




YEAR of HORTICULTURE 2012

सत्यमेव जयते

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