



# PLANT PROPAGATION



Propagation of plants involves the formation and development of new individuals, which are used in establishment of new plantings. It is simply the reproduction or multiplication of a plant from a source that is often referred to as a mother plant. In general, two methods are employed: (1) sexual, and (2) asexual. Sexual propagation is multiplication of plants from seed, and asexual or vegetative propagation involves starting a new plant from some vegetative part of a plant. Litchi can be propagated by seed as well as vegetative means. Propagation by seed results in seedling variability. Although genetic variability is necessary if one is searching for a plant with improved or different characteristics, it is an extreme disadvantage for a nursery operator trying to produce a uniform crop containing chosen desirable characteristics. Further, seedlings of litchi plants grow relatively slow and remain in a juvenile stage for a long period of time. Seed propagation is not practised in litchi as plants raised by this method fail to bear true to type fruits. However, seeds obtained through crossing two selected parents in a planned breeding programme may be a valuable source of variation in yield and fruit quality. Plants in a juvenile stage of growth may have leaf and growth habits different from desirable characteristics in a mature form of the plant.

Litchi seed is recalcitrant in nature and therefore, loses its viability in a very short period if it is exposed to air in the shade under normal humidity conditions. The seed begins to shrivel within 24 hours and in five days it becomes incapable of germinating. Seeds can be preserved for up to 8 weeks between 2-2.5 cm thick layers of wet sphagnum moss or, for somewhat shorter periods, if wrapped in peat in a refrigerator. They may also be stored for at least a month in the shade, in closed petri dishes dusted with captan at temperatures of 15°C to 25°C, without losing their germinating capacity. Another method of preservation is to leave the seeds in the fruit. This prevents them from drying and preserves their viability for at least 3 to 4 weeks. Eighty per cent of fresh seeds germinate after three weeks, provided soil water and aeration are adequate. Large seeds germinate better than small seeds and also have stronger growth initially. In contrast, chicken-tongue seeds are not viable. Growth is usually better with organic mixes, acid pH and inoculation of mycorrhiza.

After separating from the fruit and cleaning properly, the seeds must be sown horizontally to a depth of 1-2.5 cm in a well-drained sowing medium in partly shady, well irrigated location. The sowing medium may be either sand or various mixtures of sand, vermiculite, soil and compost provided that they offer good aeration which is considered essential for seed germination. Incorporation of soil from old plantations into the sowing medium usually encourages germination because of the positive effect of the mycorrhizal presence. This practice is not always recommended since the soil may contain pathogens, nematodes, etc., which could attack the root system. The compulsory disinfection has to be done in such cases. Germination commences within three days, under normal conditions. Seeds should be sown in trays and transplanted into individual bags when the young plants have reached a height of 10-15 cm. Only mature seeds must be used for propagation purposes. For obvious reasons, small seeds in which the embryo has aborted must never be used for sowing.

To facilitate transplanting, the seeds should be sown at a distance of not less than double their length and depth double to their width. The seedlings should also be watered regularly and protected from biotic and abiotic stresses. Temperatures from 25° to 30°C with high humidity are ideal for litchi seed to germinate. However, litchi propagation from seed is unsatisfactory and not usually recommended, because varieties do not reproduce true-to-type and have poor to average fruit quality. Seedling trees often take more than 10 years to come into bearing. This type of propagation is, therefore, used only in research work or to produce rootstocks. New cultivars can be developed from the selection of seedlings with improved characteristics. New cultivars might bear more regularly, earlier or later than existing cultivars. They might also have larger fruit, brighter skin or smaller seeds. Seedlings that are to be evaluated as potential new cultivars can be planted out after a year. They are usually planted closer than in commercial orchards preferably, two meters apart.

### Asexual Propagation

Asexual propagation is the multiplication of a plant through some vegetative parts. Plant propagation methods that are included in this system are cuttings, layering, and grafting.

#### Cuttings

Spring and autumn season are the best time for planting the cuttings. The semi-hard to hard wood cuttings with two leaves, measuring approximately 13-20 cm in length and 15 mm in diameter, taken from young and vigorous trees. Different growth regulators may be used to promote rooting. Good response in cuttings can be obtained by over night dipping in 100-200 ppm IBA. 2000 to 5000 ppm of indolebutyric acid (IBA), indoleacetic acid (IAA) and nephtalenacetic acid (NAA) through quick dip methods are the most successful growth regulators. The basal ends of the cuttings are usually dipped in the hormonal powder or in a solution of auxins for a few seconds. In some case, a fungicide (Bavistin) should also be added to the growth regulator.

Once the cuttings have been prepared, they must be placed in a propagation bed, under mist. The medium should be as loose as possible and preferably temperature should be maintained between 30-32°C. Because litchi rooting is a slow process, the cuttings must remain in the rooting bed for 3 to 4 months. Only when a good root system has been formed, they can be transferred to bags. Once transplanted, they must remain in a greenhouse for 15-16 months before finally being planted in the field. If cuttings are few in number or are being prepared for experimental purposes, it is advisable to place each one in a small, transparent plastic bag so that progress can be easily observed.

Attention must be drawn to the fact that genetics plays an important role in rooting success of cuttings. Because of the slow development of callus tissue, the slow-growing cultivars do not root well. Success also depends on selecting the correct type of wood, misting or fogging, and good temperature control in the propagation house. The rooting media also needs free drainage. Some cultivars can provide 80 per cent success rate. Young plants of about 50 to 60 cm height are recommended for planting because smaller plants often die in the field. Sixty to eighty per cent of semi-hardwood and hardwood cuttings get rooted with shoots collected from older wood behind the soft tips prior to flowering. Soft terminal cuttings are unsuccessful therefore, should be avoided for cuttings. Better results are obtained if the shoots are girdled a few months before taking the cuttings because of accumulated Carbohydrates in the above girdle portion.

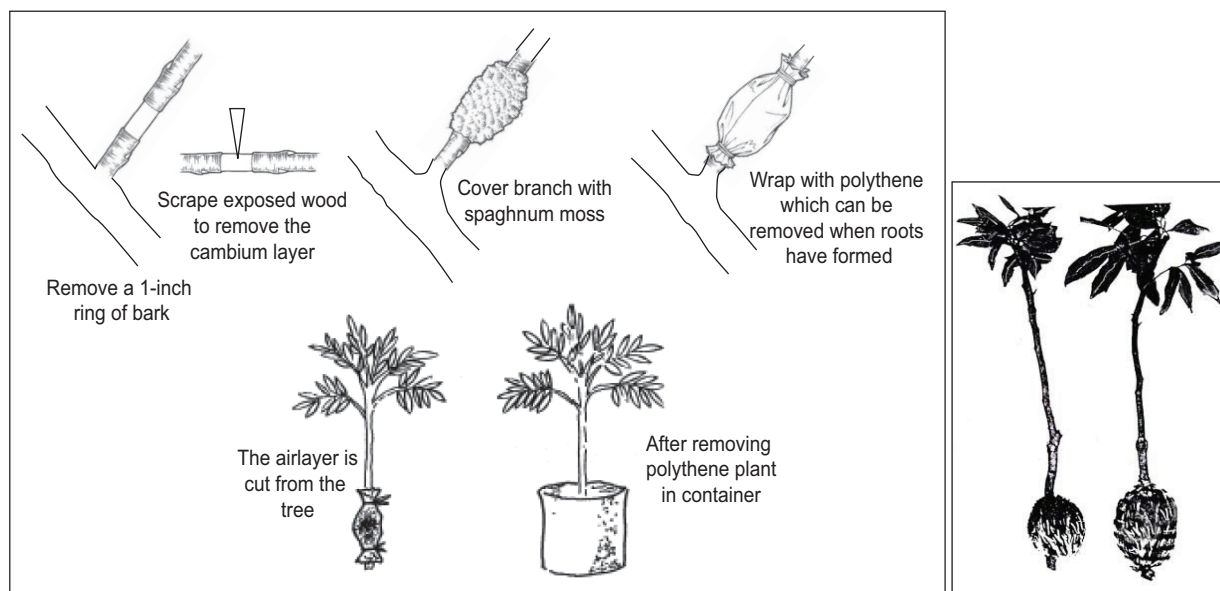
Although, on some occasion, rooting has been 90 per cent successful under 100 per cent humidity conditions but litchi propagation by cuttings does not always have the desired results. The method calls for expensive, complex installations and the plants produced are weaker and root systems usually less developed than those obtained by layering.

### **Air Layering**

Air-layering or 'gootee' is widely accepted method of litchi propagation. This is the most widely used propagation method and the one, which gives the most satisfactory results. Its major advantages are that it is simple to use and genetically identical plants are produced. The most serious drawback of air layering is the damage to the parent plant if a large number of layers are required and poor survival in the nursery after shifting of layers. Plants prepared by this method are delicate and difficult to transport.

Air-layering is done when leaves of the previous growth flush have proper maturity. Even though, it has been reported that the better the branch used, the better the root system obtained. Excellent results can be obtained with branches of 10-25 mm diameter and 46-60 cm length. These shoots produce rooting rate above 90 per cent and damage to the mother plant is also minimal. Air layering can be done at any time of years as long as there is sufficient moisture, but best results are obtained in rainy and spring season. Branches should be selected on the periphery of the trees, so that they can easily be worked on. The selected branch should consist of a single stem and other stems must be removed. Preference should

be given to branches that are erect and in satisfactory physiological conditions i.e. the last vegetative flush must be well advanced. The pictorial representation of air layering process has been shown in Fig. 4.1.



**Fig. 4.1: Air-layering in Litchi and air-layers ready for planting**

A ring of bark measuring 2.5 cm width is removed from the branch at the point where root formation is desired. The thin cambium layer beneath the bark is scraped away. For best results, this ringed area should be left exposed for few weeks until callus tissue begins to form at the end toward the branch tip. If air-layering is done too soon after branches are ringed, rooting often fails. This is because freshly exposed cambium cells may continue to divide and overgrow the ringed area, thus inhibiting rooting. An ordinary knife or clippers may be used for this operation. The ringed area should be surrounded by a layer of moss of about 2.5 cm thick and 10 cm long. The traditional method used soil, organic matter, sawdust and woodchips wrapped in cloth to enclose the rings. However, moist peat moss and polyethylene bags are now used in many areas. The use of the plastic alleviates the problem of daily hand watering. A medium consisting of 100 per cent peat moss and limed to a pH of 6 is ideal. Auxins sometimes improve rooting, but are not essential. The plastic wrap ends are tied tightly around the branch with string and sealed with plastic tape to keep rainwater out.

Under adequate conditions (temperatures 25-30°C), two to four months after layering several roots are formed and are visible changing colour from white to creamy brown through the plastic film. The air-layered branch is then cut off immediately below the plastic. The wrapping is then removed and the rooted air-layer planted in a suitable container. Special care must be taken to avoid damage to the young root system while transplanting. Use of root trainer and organic matter rich rooting media has been found to promote the secondary



and tertiary root in the litchi air layers which improves the establishment. Application of super phosphate in rooting medium of root trainer also improves root growth.

The planting must not be done in dry weather. It is also necessary to reduce the foliage on the plant by about half. The young plants must be placed in individual bags of 18x15x35 cm filled with a well drained, dense mixture, which must be carefully packed around the bag containing the roots. The trunk and rooted area should not be buried more than 2.5-5 cm below the level of the soil in the container. Containers with newly transplanted air-layered plants should be placed in a shaded area for about two weeks with a lightweight plastic bag placed over the plant to retain humidity until the plant begins to put out new growth. Later on, the plants can be gradually exposed to full sun to “harden.” Two or three vegetative flushes must appear before the plants can be hardened off in the open air prior to final planting. The whole process, from the start of layering operations to transplanting into the field takes between 12 and 18 months.

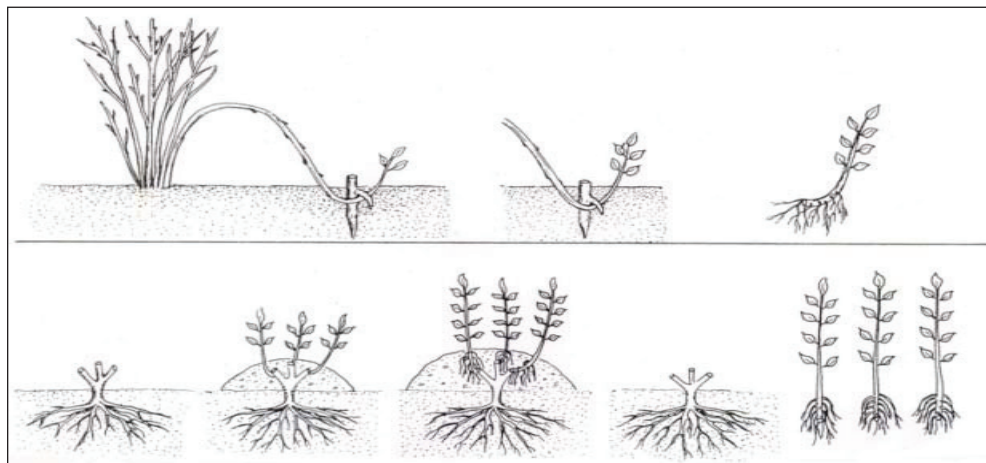
Transplanting to the field is best done during a rainy season, but if this is not possible, the plants should be watered every two to three days until well established. Removing about half of the leaves at the time of planting in the container and again when transplanting to the ground will prevent excessive moisture loss. Major bottleneck associated with this method of propagation is the high mortality of layers after cutting them from the mother plants and establishment in the nursery on their own root systems. Time of layering plays an important role in rooting and production of quality layers, because root induction during layering may be associated with the particular physiological conditions in the stem.

### **Stool Layering**

It involves cutting of a 2-3 years old well established air layered litchi plant in the month of February at 25 cm from the ground level. After a month 6-8 side shoots appear. Except one shoot all the other shoots are selected for stooling in the month of June. A ring of bark measuring 3 cm width below 20 cm from the tip of the shoots is removed. A paste of IBA (2500 ppm) is applied to the ringed area. Ten days later, soil is mounded around the base of the newly developed shoots so as to cover 10-15 cm of the stem above the ring to encourage adventitious roots. This causes the shoots to root profusely in 2 months. The rooted shoots are separated from the mother plant in the month of September and immediately planted in nursery beds or pots. It is reported that the transplanted shoots have a survival rate of 81-82% as compared with 40%-50% in air-layers. A pictorial representation of stool layering is presented in Fig. 4.2.

### **Grafting**

Grafting is the act of joining two plant parts i.e. rootstock and scion together. The upper part of the graft (the scion) makes the top of the plant; the lower portion (the rootstock) makes the root system and part of the trunk. Litchi is a plant which does not graft easily. This is



**Fig. 4.2: Process of mound layering or stooling in litchi**

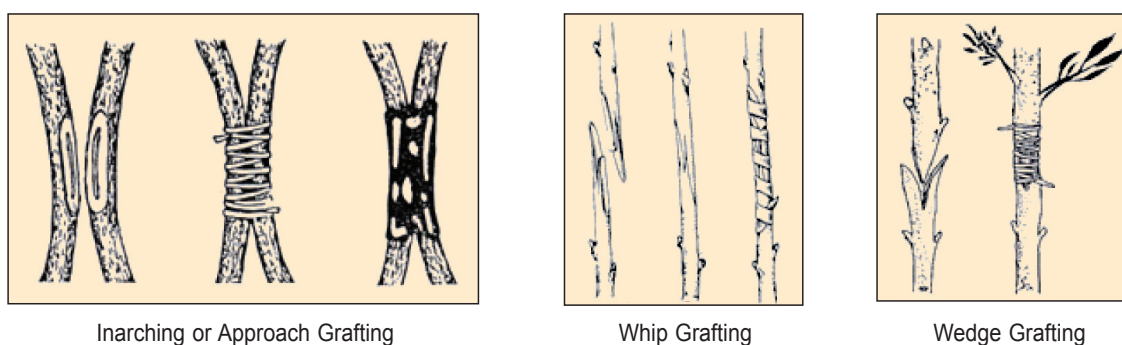
basically due to the fact that cambium is active over only about one-third of its circumference at any given time except when the plant is very young, During a given growth period, tissue development takes place on one side of the matrix and during a subsequent vegetative flush, another part of the cambium becomes active. The whole process is regulated so that a fairly symmetrical cylinder of wood is formed. Successful grafting depends largely on cambium activity occurring in areas adjacent to point of graft operation, 'the matrix'. It has been reported that the cambium layer in litchi is not continuous and thus the success depends much on the factors related to the technique of grafting.

Grafting, however, has some unique advantages. It is used to perpetuate plant types that will not come true from seed; to adapt plants to unfavorable soil or climatic conditions; to control or prevent pest or disease incidence; to control the height or size of a plant; to change the top of a mature plant to another cultivar; and occasionally to repair rodent, machinery, or adverse weather damage to trees. In addition to being a propagating mechanism, grafting is occasionally used for other horticultural purposes. Twisting together limbs in an approach graft across a weak crotch angle can greatly strengthen the framework of a tree. Grafting can also be used to insert pollinator branches into a tree that requires pollination by another cultivar. Already mentioned is the use of bridge grafting for repairing bark-damaged trees. Another use is to change the cultivar of a mature tree, which can be done by gradually cutting off older limbs and replacing them by budding or grafting with branches of the new or desired cultivar. Changing the cultivar of an old tree by grafting is called 'top-working'. Through grafting it is possible to have fruits of different varieties on a single tree.

Grafting to control size is an ancient practice. Dwarf fruit trees have been a real boon to the growers not only because they are small enough to grow but also because they produce sooner after being planted and are much easier to prune, spray, harvest, and otherwise take care of. Growers frequently ask if fruit quality is affected by the rootstock. In general, dwarf fruit trees produce fruit of just as high quality as do normal-sized trees. In some instances fruit

quality of the dwarfs will be higher, either because they are easier to thin out by pruning or because they do not tend to produce as much shade as do normal tree's, and abundant light increases color and flavor. In a few instances quality of the scion may be affected by the root. This is probably due to the effect of the rootstock on the carbohydrate/nitrogen ratio rather than directly on the quality. Grafting may also be used to stimulate growth or at least provide a better root system for plants that normally produce a poor one. Dwarf trees should be planted so the graft union is above the soil surface, otherwise the scion will form a root system of its own and the effect of the rootstock will be lost. Branch growth originating below the graft union should be removed, because it will not be of the desired cultivar and often outgrows the scion resulting into poor quality fruit production.

Although some litchi cultivars may show incompatibility reaction, in general grafting has been used successfully in China and Viet Nam to propagate litchis commercially. The Chinese grafted and budded new cultivars several centuries ago, but they relied mainly on layers for commercial propagation. It is only recently that this method has been evaluated in high-density orchards. Little thought has been given for using rootstocks to control tree growth, productivity and fruit quality as in apple and stone fruit. Related species and ecotypes have been suggested as potential rootstocks, but no commercial orchards have been developed on these systems. Budding and grafting often fail because of incompatibility between the scion and stock. Poor grafting technique, grafting at the wrong physiological stage and poor care in the nursery can also cause problems. Incompatibility has been reported in some countries. A number of grafting methods have been tried with varying level of success. Schematic diagram of 3 popular methods of grafting in litchi has been presented in Fig. 4.3.



**Fig. 4.3: Different techniques of grafting litchi**

### **Approach Grafting**

The distinguishing feature of approach grafting (Inarching) is that two independently growing, self-sustaining plants are grafted together. This self-sustaining characteristic of both plants which are to be grafted insures survival of both even if the grafting attempt is not successful. However, the chance of being successful is greatly enhanced because of the active growing condition of both plants involved. For inarching, plants of an established seedling are planted close to the base of the mother plant, without extensively damaging the root structure of

the established plant. From both plants, closely position shoots which are at least of pencil diameter or preferably close to the same size are selected. At the point where the union is to occur, a slice of 3.0-5.0 cm bark along with some wood is removed from both stems uniformly. The both surfaces are then bound tightly together with budding or electrical tape. Completely wrapping is done around the joint area. Some of the top portion of the foliage is removed from the adapted variety 15-20 cm above the graft union. This encourages a more rapid healing of the grafted union.

The union in this method completes in four weeks. This type of grafting is most successful if performed during growth season. After the parts are well united (4 weeks or more), the remainder of the top of the rootstock plant and base of the scion variety can be cut off immediately. Immediately after the portion of each plant is removed, it may be necessary to reduce the leaf area of the top. A high proportion of graft success is obtained with this method, but its use in commercial nurseries is rather limited since adult, established plants of the variety to be grafted, must be available so that potted plants grown from seed may be placed next to them. The method does not overcome the difficulty of introducing cultivars into new areas although plants obtained in this way may later be distributed elsewhere.

### **Side Grafting**

The scion should have to three buds with a length of about 8-10 cm long. It is usually recommended to girdle the branches from where the scions are taken before 21 days of grafting. For autumn grafts short (3-4 buds), round scions of green with completely mature wood (just before the opening of the new shoots) are preferred, while for spring grafts, hard and semi-hard wood is chosen. In any case, the wood must be relatively mature which is about to begin a new vegetative flush of growth. A wedge is made at the end of the scion slightly thicker than the other. It is not necessary to make the cuts more than 2.5-3 cm long. Cuts must be made straight and smooth, with a single movement of a sharp knife. A smooth area 15-20 cm above the base of the rootstock is selected and a slanting cut is made into it. The cut should angle downward and extend about halfway through the branch. The upper part of the stock back is pulled to open the cut. The scion is inserted into the open cut with the slightly thicker side lying along the cambium. The scion is set at a slight angle to give maximum contact. When the top is released, the scion should be held in place, so that no wrapping is necessary however, some people prefer to wrap the union. It is done carefully, so the cambial alignment is not disturbed. The rootstock branch should then be cut off 12-15 cm beyond the graft. Any lateral branches on the rootstock that might cover the graft are removed, as it begins to grow. After several weeks, when the scion has started growth, the remaining shoot of the stock should be carefully cut closer to the graft.

Under favourable temperature conditions, buds begin to sprout within 3-4 weeks and the tops of the stocks may be cut off two to three weeks after the scion has been inserted. The new trees may be planted out once they have hardened off sufficiently and reached a height of

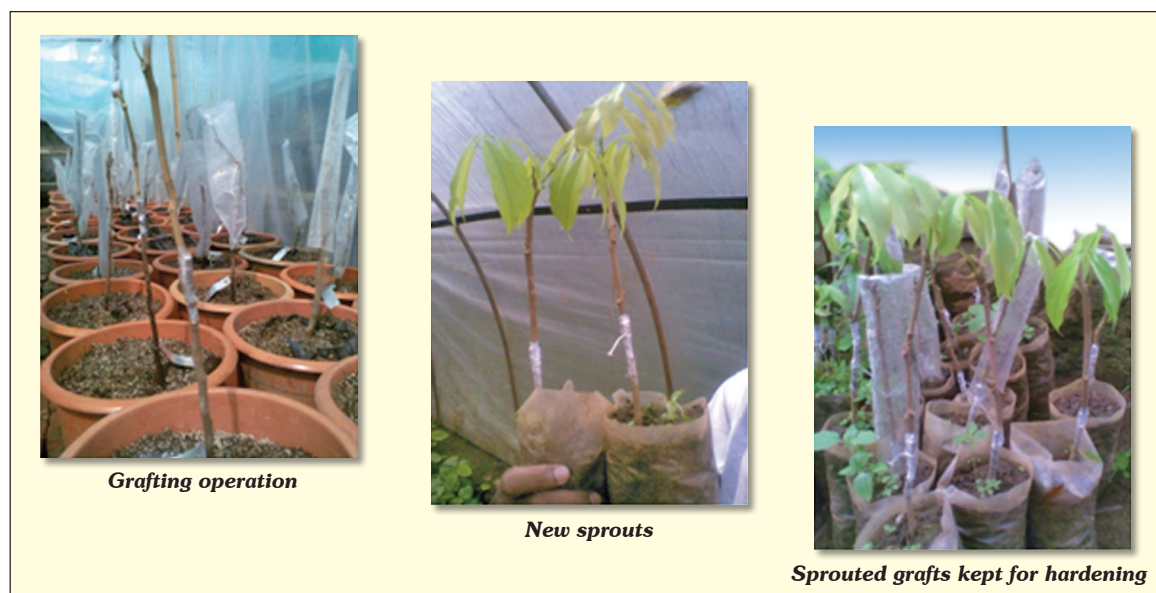


50-100 cm, but not later than one year after grafting. To reduce costs, it is always convenient to graft plants in small bags (4 kg capacity), at the start of the growing season and then into larger bags (about 13 kg). It has been seen that with side grafting, the stock contributes more significantly to callus formation than does the cultivar, while with approach grafting, the faster growing symbiont makes the greater contribution. This means that fast-growing plants which can be selected from nurseries prior to grafting should be preferred as rootstock and, in principle; seeds from the more vigorous varieties should be used. Seeds sown in early summer are ready for grafting the following autumn or spring.

### **Wedge Grafting**

The wedge graft is fairly easy and heals rapidly. It works best when the rootstock and scion are of similar diameter preferably between 0.7 and 1.25 cm. The scion is first prepared by girdling branches of new growth 21 days prior to grafting. Girdling involves removing a strip of bark approximately 6 mm in width, situated some 0.5 m from the apex, over the entire circumference of the branch. Scions are taken only from young trees which had a period of vigorous growth. Scion material up to 6mm thickness may be used. The scion must be approximately 10 cm long and contain at least 2-4 buds. It is preferable to use wood from the previous year rather than young terminal wood.

A long, slanting cut is made in the rootstock 30 cm above the ground at a point where the diameter of the stock is the same as that of the scion. This cut must not be less than 2.5 cm long, 4mm thick and in stock and somewhat longer if the stock is wider in diameter. It is nevertheless not recommended to use stock more than 1 cm thick. The grafting operation is performed as per the sketch shown in Fig. 4.3 and the plants sprout as shown in Fig. 4.4.



**Fig. 4.4: Wedge grafting in litchi**

### **Managing Nursery Stocks**

Fertilizers can be applied once the young plants begin to produce new growth. Fertilizer application is to be done very carefully. Vigorous growth of plant is always attractive to the buyer. Heavy manuring is not beneficial for storage of plants. Light manuring, watering is also important. Watering is done according to need of the plant. The nursery should have a water source of its own. Digging a well (12 m deep x 3 m diameter) and installation of a 2.0 HP pump set with accessories are considered appropriate. Sprinkler system of irrigation is not advisable at the beginning.

For sufficient vegetative and reproductive growth of plants, good drainage system must be developed in between the beds and around the nursery. Adequately gentle slope in the pot bed surface is also desirable. It is extremely important to ensure that water logging does not occur in and around the pots and beds. Keen observation on attack of different pests and diseases is required. If the mother plants are infected, the propagated plants will also be infected therefore, necessary control measures in mother plants as well as in nursery plants should be taken immediately on observation.