



**FACULTY OF AGRICULTURAL SCIENCES & ALLIED INDUSTRIES**

Budding is a form of grafting in which one bud and a small section of bark with or without wood is used, in comparison to grafting, in which the scion consists of a short-detached piece of stem tissue with several buds. Chip budding and T-budding are the most important types of budding for fruit crops and woody ornamentals. The type of budding method to be adopted depends upon the bark's slipping, ability of the stock and scion, which coincides with the period of active growth in season and when newly formed tissues are easily torn as the bark is lifted from the wood. Among the different methods, chip budding can only be done when bark is not slipping.

## Advantages

- It is the best propagation method if the propagating material is scarce and valuable.
- Budding is useful in plants, which release excessive wound gum (e.g. stone fruits) from injury caused to wood portion of the stem at the time of grafting.
- Budding union is stronger than grafting so damage by wind or storm is less compared to grafted plants.
- Budding is comparatively simple, efficient and quicker method of propagation than grafting.

## Selection of bud-wood

- While selecting bud-wood, one should be careful enough to use vegetative buds than the flowering buds for budding.
- The vegetative buds are usually small and pointed while flower buds are large and plump. In case of bud wood to be procured from distant place, the leaves must be removed by leaving petiole intact.
- The bundle of bud-wood should be packed in moist jute or sphagnum moss, or cloth and should be kept moistened in the transit.

## Time of Budding

Budding time usually depends upon the availability of well developed budwood of the desired cultivar. In most plants, these conditions exist at three different times during the year:

### 1. Spring budding

- In spring budding, the bud must be dormant and the rootstock just begins to start growth as soon as the bark slips easily on the rootstock.
- The period of spring budding is short and should be completed before the rootstock has made much new growth. Due to combination of dormant bud and active growing buds on the rootstocks, the bud sprouts and develops easily.
- The bud sticks are collected well in advance of actual budding operation and stored at  $-2$  to  $0^{\circ}\text{C}$  temperature to hold them dormant by wrapping them in moist jute cloth or sphagnum moss.

- The rootstock top is cut after 2-3 weeks of budding, when healing has taken place, by giving a slanting cut. Spring budding is commonly done in citrus.

## 2. June budding

- June budding is done in early part of the growing season i.e. mid-May to mid-June. Budding is done in the early part of the growing season and the inserted bud is forced to sprout immediately.
- The bud is taken from the current season's growth. This method is preferred in areas having relatively long growing season. June budding is used mostly to produce stone fruits (peaches, nectarine, almond, apricot, plums, cherry, *ber* and *aonla* etc.).
- A seedling of 30 cm height, 3-5 mm diameter can be used for budding. June budding should not be done after late June, so as to obtain nursery plant of satisfactory size.
- In June budding, the rootstocks are smaller and have less stored food in them. Usually, 3-4 leaves are also retained below the bud.
- The healing of bud usually takes 2-3 weeks under normal environmental conditions. If leaf stock or petiole drops off cleanly, it is a good indication of bud union and if it has adhered strongly and starts shriveling and darkens, it indicates budding failure.
- The rootstock is immediately cut after healing process, leaving at least one leaf above the bud and several below. Other sprouts should be rubbed off or discouraged to ensure fast growth of scion bud.

## 3. Fall budding

- Fall budding is particularly important in northern areas and cold deserts where the growing season is short. Fall budding is done in late summer, and not in autumn.
- The rootstock are large enough by late summer to accommodate the bud and the plants are actively growing with the bud bark slipping easily, should be moderately vigorous, actively growing and containing healthy bud in the leaf axils.
- As bud sticks are selected, the leaves should be cut off immediately, leaving only a short piece of leaf petiole attached to the bud to help in handling the bud while performing budding.
- The best buds on the stick to be used are usually on the middle and basal portion. Buds on the succulent terminal portion of the shoot should be discarded as they are immature.
- After the buds have been inserted and tied, nothing needs to be done until the following spring. If the budding operation is done properly, the bud piece should unite with the rootstock in two to three weeks, depending upon growing conditions.
- Even though the union has formed, buds on most deciduous species usually do not grow or push out in the fall, since they are either in a physiological rest or inhibited by apical dominance.
- By spring, the chilling winter temperatures overcome the rest influence and the buds start growing. Most of the tropical, subtropical and temperate fruits like *aonla*,

mango, guava, *ber*, *bael*, jackfruit, stone fruits, walnut, chestnut and hazelnut etc. are propagated during this period.

### Stages of Bud/Graft Union Formation

There are four stages viz; pre-callus, callus formation of cambial bridge and healing of the bud union.

**Pre-callus stage:** It lasts for 5 to 8 days, after budding or grafting operation. During this stage, there is no sign of callus formation and scion falls if the wrapping material is removed. **Callus formation:** After 5th to 8th day, the callus formation may take place in the bud/graft union. The process of callus formation is fast in firmly attached stock and scion. The initiation of callus formation takes place either from stock, scion or both. Usually, living cells of recently formed xylem and phloem play active role in the callus formation.

**Formation of cambial bridges:** The paranchymatous cells of the callus form a cambial bridge within 12 to 15 days after budding. After the formation of cambial bridge, de-differentiation of secondary xylem and phloem takes place after 36-48 days of budding. Afterwards, the partial movement of stock to scion takes place. The bud union is completed within 6-7 weeks, if conditions are favourable.

**Healing of the bud/graft union:** After de-differentiation of secondary xylem and phloem of both stock and scion, there is formation of many new xylem and phloem cells after 6-8 months of budding or grafting. The callus unites completely with the scion pith and the union heals completely. In general, better contact and alignment of the cambial cells of stock and scion helps in development and proliferation of callus.

### Methods of Budding

**Chip Budding:** Chip budding is done in early spring, summer or autumn. In chip budding, a chip of bark and wood is removed from the smooth surface between the nodes of the stock. The various steps involved are shown in Plate 8.1. A chip of similar size and shape is also removed from the bud wood of the desired cultivar. For which, a 2-3cm long downward cut is made through the bark and slightly into the wood of the stock. Then a second cut of about 2.5cm is made so that it bisects the first cut at an angle of 30-45° and the chip is removed from the stock. Similarly, a chip of bud is removed from the budwood, ensuring that the bud is in the middle of chip. The bud chip inserted in the stock in such a way that cambium of the bud chip should have direct contact with the cambium of the stock. It is then tightly wrapped with polythene strip, leaving the bud uncovered. The bud may sprout after 3-4 weeks and afterwards the wrapping material should be removed. When the bud starts growing, the stock may be cut above the bud union.

**Shield or T-budding:** As the name indicates, shield is the shape of the bud and 'T' is the shape of cut given on the rootstock. It is the most common method of budding used by nurserymen worldwide. The various steps involved are shown in Fig.8.1. For shield budding, one year old

rootstock seedlings of 25-35 cm height and 2-2.5 cm thickness is selected. The bark of seedlings should slip easily. The selected bud of desired cultivar is inserted 15-20cm above the ground level and is tied with a polythene strip.

For performing budding operation, a “T” shaped cut is made on the selected portion of the stock with the help of a sharp budding knife. The incision should be given through the bark not the wood. The two flaps of bark are loosened with the help of budding knife. The healthy bud is removed from the bud wood by cutting shallowly about 5-6 mm below and 2-3cm above the bud. This shield piece containing a bud is inserted in the “T” cut made on the rootstock. The shield should be covered by two flaps of the bark, but bud should be exposed. The buds are pressed firmly, fitted into the “T” cut and finally tied with polythene strip. When bud healing process is over, the bud may attain a height of 15-20cm, the remaining portion of the stock is cut to about 10-15cm above the bud. Plants with thin bark, with sufficient flow of the sap like apple, pear, peach, plum, apricot, cherry, rose and citrus are propagated by this method. Patch budding: In case of patch budding, a rectangular patch of bark is removed completely from the rootstock and replaced with a patch of bark of the same size containing a bud of the cultivar to be propagated. It is a slower and difficult to perform method than T-budding. It is widely used in thick-barked species, such as walnuts, pecans and rubber tree, where T-budding gives poor results due to poor fit around the margins of the bud-particularly the top and bottom. It is usually done in late summer or early fall, but can be done in spring also

In patch budding, the stock and scion should preferably be of same thickness (20-25mm). The various steps involved are shown in Plate 8.3. First, a rectangular piece of bark (25mm long and 10-15cm wide) is removed from the stock and a similar patch, containing a bud is removed from the scion by making two horizontal cuts above and below the bud and then two vertical cuts connecting the horizontal cut.

After removing the patch, the bud should fit tightly at the top and bottom. It is then wrapped with polythene strip, keeping the bud uncovered. The wrapping material should hold the bark tightly and cover all the cut surfaces to prevent free entry of air or water or pathogens. After the bud starts sprouting, the stock above the bud union may be cut off step-by-step. In addition to pecan nut and walnut, mango, rubber plant, *aonla*, jackfruit and *jamun* are also propagated by this method.

**Ring or annular budding:** In this type of budding, a complete ring of bark is removed from the stock and it is completely girdled. A similar ring of bark containing a bud is removed from the bud stick and is inserted on to the rootstock. The various steps involved are shown in Fig.8.2. The thickness of stock and scion should be of same size. It has been utilized in ber, peach and mulberry because the newly emerged shoots from the heavily pruned plants are capable of giving such buds for budding, which can be easily separated. In this method since the stock is completely girdled and if the bud fails to heal in, the stock above the ring may eventually die.

**Forkert budding:** In forkert budding, the stock is prepared by giving two vertical cuts and a transverse cut above the vertical cuts to join them. The bark is removed carefully along the cuts, so the flap of bark hangs down. The scion is prepared in a fashion similar to patch budding, having the size similar to cuts made on the stock. The scion is then slipped into the exposed portion of the stock and the flap is drawn over the inserted bud patch. It is then tied with a suitable wrapping material. After successful growth of bud, the portion of stock above the union is removed carefully.

**Flute budding:** In flute budding, the patch of bark is removed from the stock in such a way that it almost completely encircles the stock except with a narrow bark connection between the upper and lower cuts on the stock. A similar patch of bark is removed from the bud stick containing a healthy bud. The shield containing the bud is then inserted in the vacant area of the stock and the shield should fit tightly on the stock. It is then wrapped with suitable wrapping material, leaving the bud uncovered. The other procedure is same as in patch budding. Because of the presence of a narrow connecting strip of bark on the stock, it remains alive even if the bud fails to sprout.

**I-budding:** In I-budding, the bud patch is cut in the form of a rectangle or square like patch budding. With the same parallel-bladed knife, two transverse cuts are made through the bark of the rootstock. These are joined at their centre by a single vertical cut to produce the shape of letter-I. The two flaps of the bark can then be raised to insert the bud patch beneath them. A better fit may occur if the side edges of the bud patch are slanted. While tying the I-bud, one should ensure that the bud patch does not buckle outward and leave a space between the rootstock. I-budding is the most appropriate method of propagation when the bark of the rootstock is much thicker than that of the bud stick. In such cases, if the patch buds are used, considerable paring down of the bark of the rootstock around the patch would be necessary.

**Micro-budding:** Micro-budding is used successfully for propagating citrus particularly in Australia. It is similar to “T” budding except that the shield (bud piece) utilized is thin and tiny like “T-budding”; the micro-budding is also not done under aseptic conditions. The petiole is cut off just above the bud and then bud is removed from the bud stick by a flap cut just underneath the bud. Thus, only the buds are utilized in micro-budding. In stock an inverted “T” cut is made and the tiny shield containing the bud is inserted in it and later tied with a thin plastic tape. The tape may be removed soon (15-20 days) after the healing has taken place.