BUDGRAFTING FRUIT TREES.

Rapid progress has been made during the past few years at the Central Experiment Station, Serdang, in the propagation of fruit trees by budgrafting. The technique employed has been successfully applied to the rambutan, pulasan, mata kuching, avocado pear, various species of citrus, carambola, bullock's heart, soursop, custard apple, Brazil nut and sapucaia nut. The durian still presents certain difficulties which, however, it is hoped will soon be overcome.

Budgrafting is an economical method by which supplies of fruit trees with desirable characters may be increased. Trees so propagated bear fruit earlier and are usually more fruitful than those raised from seed. Budded trees are more uniform in growth, habit, and period of fruit production than seedlings. In the past, the better races of rambutan, oranges and the like, have been propagated by marcottage (*tut*, Malay). This method, although achieving its object in raising stock of known quality, has certain disadvantages, *e.g.*, extravagance in use of material, severe mutilation of the mature trees, and lack of uniformity in subsequent habit of growth of the marcot.

Furthermore, the establishment of marcots on their own roots is not easy, and mortality among marcots after they are severed from the parent tree is frequently heavy. In the case of the rambutan, the marcotted tree has recently been found to be smaller and to possess a less efficient root system than a budgrafted tree of the same age. The root system of the former is superficial, while the budgrafted tree, in addition to having a superficial root system as large as that of the marcotted tree, has a tap root system penetrating deeply into the soil, thus providing additional anchorage and enabling the budgrafted tree to draw upon a greater area for soil nutrients and moisture. It is not yet known whether other fruit species differ in the above respects.

General Principles.

Budgrafting is performed by removing a dormant bud or eye from a branch of the tree to be propagated (Figs. 2 and 3) and inserting it beneath the bark of the stem of the stock. The conditions necessary for success in this operation are as follows:—

(a) The stock and scion should be sufficiently mature and both in active growth, so that the bark will lift easily from the wood.

(b) It is essential that the cambiums (*i.e.* the layer of tissue between the bark and wood) of both stock and scion should be in direct contact.

(c) A sharp knife is necessary and should be kept in proper condition by frequent honing.

(d) Absolute cleanliness is essential.

A budgrafted plant is thus made up of two parts, *i.e.* the "stock," which is raised from seed or by some vegetative method, and the "scion" or bud.

Stocks.

There are very few recorded cases of a scion being successfully grafted on a stock which is not closely related. Usually it is possible to intergraft plants only within the genus, but certain species of different genera of the same Natural Order may be budded with success. Most fruits are best budded on stocks of the same species. Citrus fruits, however, do not always succeed best on stocks of the same species and specially selected stocks are generally used, namely rough lemon, sour orange, trifoliate orange, and several citrons. The treatment of citrus requires special attention and those interested are advised to consult reference 2.

Stocks may be raised from seedlings, established shoots or rooted cuttings. Vegetatively raised stocks are sometimes used in the case of citrus species but generally speaking seedling stocks are employed as in the case of all local fruits. Whatever their nature, however, it is of paramount importance that only strong growing healthy stocks be used. Failures have repeatedly been traced not to any fault in the actual budgrafting operation but to the use of weak slow-growing stocks. It is for this reason generally preferable to grow stocks in well-prepared nursery beds rather than in earthenware pots or bamboo joints. The latter may be used with some success, but the restricted space available for root development, with consequent danger of root binding, makes the method somewhat uncertain and it cannot therefore be generally recommended.

Budgrafting success with stocks raised in nursery beds depends largely on the care and thoroughness with which the beds are prepared. The land is first thoroughly dug to a depth of at least 12 ins. and preferably more. Lime and any wood or furnace ash that may be available is then spread at the rate of 1 cwt. per

square chain and the land is dug over a second time so as to break up the soil thoroughly. The area is then lined preparatory to making the beds. At Serdang, the beds are made 66 ft. long by 2½ ft. wide with a space of 2 ft. between the beds. About 2 cwts. of well rotted cattle manure or compost are spread evenly over each bed and, after covering the manure with soil taken from the 2 ft. space between the beds, a nursery bed raised 5 to 6 ins. is formed. If the beds are made higher than this there is a danger of the soil around the roots of the stocks drying out during drought.

Seed of all local fruits, except citrus, may be sown directly in these beds or seedlings or vegetatively propagated young plants may be transplanted to them. In either case planting is done in two rows 15 ins. apart and plants spaced 15 ins. within the rows. A light shade of palm or other leaves is placed on a bamboo or jungle timber structure 2 ft. above the surface of the bed to protect the young plants from the effects of strong sunlight and beating rain. When the young stocks become firmly established (about 2 to 3 months from seed planting in the case of most local fruits) the overhead shade is gradually dismantled until the plants are completely exposed.

Planting of seed and transplanting of seedlings or vegetatively propagated young stocks should only be undertaken during wet weather unless arrangements can be made for daily watering in the initial stages. This emphasizes the importance of a plentiful water supply in the nursery area. At the time of planting or transplanting watering must be done irrespective of the season.

In the case of transplanting, watering facilitates the lifting of a ball of earth surrounding the roots of the seedling or young stock which minimizes the shock of removal.

When the stocks are 4 to 5 months old an application of 3 lbs. of a mixture consisting of 2 parts basic slag and 1 part sulphate of potash per bed of 66 ft. × 2½ ft. is recommended.

Buddable rambutan stocks raised by the method described have been obtained at Serdang in 8 months from the time of planting the seed.

Citrus requires special care and the stocks are best raised under cambric shelters as a precaution against insect attack. The seeds are sown closely. When 6 months old the seedlings are lifted and, after the removal of the end of the tap-root, are transplanted in an ordinary seed bed. The seedlings are sufficiently large for budding when about one year old from transplanting.

Budwood.

It is worth time and trouble to secure superior material since the quality of the budgrafted trees will be the same as the parent trees from which the budwood is obtained. This particularly applies in the case of the rambutan and citrus, but almost all local fruits show much variation in quality. The budwood obtained from selected trees is cut into pieces about 12 ins. long, each piece carrying a number of dormant buds. Budwood should be a branch or shoot removed from the tree at a time when there is a new flush of growth (Fig. 1). At this time the bark will easily peel from the wood. The budwood should be of good normal growth, well rounded and sufficiently hardened to permit of handling. For most fruits, budwood about one year old without leaves is used, but at times this is difficult to obtain. When leaves are present, suitable budwood may be obtained by removal of the leaf blade about 3 weeks before use. This causes the petioles to drop off, leaving suitable dormant buds for propagation.

Budwood, after being removed from the parent tree, should be transferred to a shaded situation and its lower ends placed in water. If it is desired to transport the budwood some distance, the cut ends should be coated with paraffin wax and packed in damp material in order to prevent evaporation of moisture.

The Budgrafting Operation.

The greatest success is obtained when budgrafting is performed during cloudy weather and with rapidity so that the exposed tissue does not become dry. It should not be undertaken, however, when it is raining or when the plants are very wet.

During hot dry weather more successful results will be obtained by budding in the late afternoon and early evening than earlier in the day. It has also been found better to bud on the shaded side of the stock. Thus, from March to September, when the sun is in the north, the operation should be performed on the south side of the stock, and from September to March, when the sun is in the south, on the north side of the stock.

The distance of the bud from ground level is determined by the conditions under which the trees are to be used. In the case of the rambutan and durian, 3 ins. from the ground is sufficient. Certain varieties of citrus are liable to be affected by fungus disease should the bud union come in contact with the surface soil, and higher budding is then advisable.

There are several methods of budgrafting practised, but the modified Forkert method is now almost exclusively employed at

Serdang, since this process has proved the most satisfactory. This method is performed by first making a transverse incision in the bark of the stock. The bark is then carefully lifted and torn downwards in one or more strips by gripping it between the blade of the knife and the thumb. About two-thirds of this strip of bark is cut off (Fig. 4), and the end of the bud-patch is inserted beneath the remains of the flap. Care must be taken to keep the bud the right way up. When tied, this flap helps to keep the bud-patch in place without pressing upon the bud (Figs. 5 and 6).

The cambium layers of the bud and stock are very delicate and easily damaged. The bud should therefore be applied directly to the stock and not slid into position, as movement between the two surfaces will damage them and produce bad results. For the same reason, care should be taken not to touch these surfaces with the fingers.

The accompanying photographs illustrate the modified Forkert method of budgrafting as applied in the case of the rambutan. Reference 1 may also be consulted.

Fig.

1. A branch suitable for use as budwood.
2. Removal of wood chip bearing the bud-patch from budwood.
3. The inner surface of the trimmed bud-patch showing the bud.
4. Stock ready for insertion of the bud-patch, showing flap of bark at base of "window."
5. Commencing to bind the bud-patch with raffia.
6. Binding completed. Note that bud is left exposed.
7. Shading the bound bud-patch.
8. The developing graft, showing support from stock.
9. The final pruning back of the stock to the union, showing application of wound dressing.

The budgrafting operation having been performed as described, bud and stock are tied firmly with raffia or other binding material (Figs. 5 and 6). Raffia is the most satisfactory for several reasons, but unfortunately it is often difficult to obtain locally. As substitutes waxed tape, nipah palm leaf strips, and fibrous strips from the false stem of the Manila hemp plant, and wild banana (*pisang hutan*) have been found satisfactory.

The buds are shaded from direct sunlight by tying over them a few leaves taken from the stock (Fig. 7).

About 18 days after budding the binding material is removed and the bud examined. If the bud-patch is green, indicating a "take," it should be re-shaded and examined again in five days' time. Should the bud still be found to be alive, the stock may be cut back leaving 3 or 4 mature leaves above the point of union. The object of cutting back the stock is to encourage the bud to sprout. As soon as the bud has 'shot' and has begun to expand its first leaf, the mature leaves on the stock should be pruned off and the young shoot supported by tying it to the stock (Fig. 8). When the young scion shoot has grown and expanded four leaves the stock should be pruned back to the union and the cut surface treated with a wound dressing such as asphalt (Fig. 9). A stout stake should then be provided to support the growing scion shoot. No lateral shoots, apart from the scion bud, should be allowed to develop on the stock after the first pruning.

Stocks which have been budded once without success may be budded a second time and if the second budding is not successful may be budded a third time. It does not appear to matter where budpatches subsequent to the first are placed so long as they are not on the side of the stock exposed to the sun. It is not, however, desirable to have a large part of the stem of a budgrafted tree of stock origin, and therefore not advisable to place more than one budpatch above the first one. This practice of rebudding stocks ensures the minimum wastage of stock material.

Transplanting.

The removal of budded plants from the nursery bed requires the utmost care if heavy losses are to be avoided. The best time for carrying out this operation is at the commencement of a wet season before the plants begin to produce new tender shoots and leaves which are very liable to wither and die back following root disturbance. At least a fortnight, and preferably longer, before the plants are finally lifted from the beds, the lateral roots are cut at a radius of not less than 4 ins. from the stock for two-thirds of the circumference and at the same time the tap-root is cut 7 to 8 ins. below the surface of the soil. A sharp cutting instrument is essential for this work; a chisel 3 to 4 ins. wide fitted with a wooden handle 2 to 3 ft. long is now generally used at Serdang. This initial root pruning should be carried out during wet weather and must be done cautiously, otherwise the ball of earth around the roots will break and the risk of loss will be increased. The