when it is possible to do things on a big scale especially in Tropical Africa, when as is subsequently suggested cultivation is to be combined with a fight against the testse fly, which not only infestsIhundreds of square miles of bush, but is encroaching an area of country that has hitherto been free of this pest.

(From the Empire Cotton Growing Review No. 4 1925)

Some Physiological Aspects of Pruning.

By Cheeseman, B, Sc.

An annual plant starting from the seed, forms first a small root and then a small shoot, utilizing for the purpose the food stored in the seed, and proceeds to grow in both directions till it flowers, sets seed, and dies. During this life-history it nourishes itself from two sources from the soil by means of its roots. and from the air by means of its green parts. The nutritive substances obtained from these two sources are of two very different kinds, but both are necessary for growth. The roots take in water and mineral salts, among which the most important salts from our present point of view are nitrates, which are built up inside the plant into more complex nitrogenous substances, whilst the leaves take in carbon dioxide, from which they build up carbhydrates, such as sugar or starch.

In the ordinary course of events the growing point, or points supplied from both sources produce for a time stem and leaves, and then flowers appear. These may be borne in various ways; sometimes they remain unchanged and the flowers are borne laterally, but in either case growth slows down, because the food materials that were being used in growth are now diverted to flower production.

The reason for this more or lsss sudden change of behaviour on the part of the growing point-the change from vegetative growth to reproduction, has for long been one of the interesting problems of plant physiology, and we are now a little nearer to a solution than we were a few years ago. It seems clear that the change is largely determined by the relative amounts of the two classes of materials, carbohydrates and nitrogenous substances, which are received by the growing points from other parts of the plant.

The nitrogen supply determines the amount of vegetative growth; it is a well-known fact that plants liberally supplied with nitrogenous manures make vigorous leaf growth, but as long as the nitrogen supply is continued produce little fruit. The carbo-hydrate supply on the other hand, is directly dependent upon the growth, for the more the growth the larger the leaf area, and consequently the greater

the amount of sugar formed. If the nitrogen supply is altogether inadequate there will be few leaves and consequently little carbohydrates formed. Under the latter conditions a starved plant is the result, which has no reserves of materials with which to form either flowers or fruit in any quantity.

The usual condition is that the nitrogen supply is ample while the plant is young and gradually diminishes later as the roots exhaust the soil in their immediate neighbourhood and come into competition with those of other plants. Meanwhile the carbohydrate supply is gradually increasing as the leaf area increases, and when the ratio of carbohydrates to nitrogen, which is thus continually rising, reaches a certain point, the behaviour of the growing points is switched over, and flowers are produced. Production of the flowers, and ripening of the seeds uses up all the available food-materials leaving no reserve for future growth, and so the plant dies.

A perennial plant, such as a fruit tree, differs in that it takes longer, for constitutional reasons, to reach the flowering stage than the annual, and consequently has greater reserves at flowering time. In exceptional cases, such as those of the Talipot palm, Century plant, and some bamboos, these reserves are all used up in one burst of flowering, but in the vast majority of cases there is sufficient food material left to permit a resumption of growth after flowering, followed by a second period of reproduction later on and so on through many years.

On a perennial plant of this kind, each bud that develops usually goes through a life-cycle similar to that of the annual. At first it grows at the expense of the rest of the plant, forming its stem and leaves, as it leaves expand and begin to manufacture sugar it becomes independent for its carbo-hydrate supply, later on it pays back into the general stock, with interest, the sugar which it used in growth later still it usually has its blooming period and finally although it does not die, it becomes more or less dormant, and serves merely as a channel through which its daughter buds are in their turn supplied with the necessities for growth, and as a storehouse in which any surplus foodstuffs accumulate until such time as the growing buds or flowers on the younger shoots draw upon them.

In some cases, such as that of cocoa, there is a slight modification of this plan, in that the flowering period is delayed, and the flower-buds remain dormant until the stem on which they are borne has shed its leaves and passed over into the last stage. The flower clusters of cocoa are really reduced branches produced from such dormant buds.

Bearing these facts in mind we can see that although the effects of pruning upon a tree are likely to be different at different stages of the tree's life, the immediate result is in any case to check fruiting. There is always a certain amount of stored material in the branches and twigs removed, and in addition to this the operation reduces the heat-surface, with the inevitable result that carbohydrate manufacture is lessened. Since the important point is the balance between carbohydrate and nitrogen, this reduction is equivalent to an increase of nitrogen, and will be followed very quickly by increased vigour of growth and production of new leafy shoots.

It does not follow that since pruning checks fruiting it is necessarily undesirable,—the fact that the practice is kept up will alone serve to prove that point. In dealing with tree crops the agriculturist has to look well ahead. A young tree just coming into bearing may have its fruiting delayed for several seasons by pruning, and yet, making stronger growth than an unpruned tree which has been allowed to fruit early, may in the long run give a bigger yield.

Another point to be borne in mind is that pruning of young trees is more often directed to producing a tree of certain shape than to affecting immediate yield. The shape will ultimately affect the yield because many trees tend, if left to themselves, to become large masses of useless branches, with their productive part reduced to a mere shell on the outside. This means a waste of space, whereas if the trees are pruned and shaped a greater number can be grown to the acre. This is not a physiological question so much as a practical one, and the planter has to decide just how far it pays him to delay, and perhaps even to reduce, the fruitfulness of individual trees, in order to have them stronger and more efficiently spaced.

To return to our physiology, we have now to consider the effect of pruning an old tree. A tree which is not manured, or which is manured inadequately, gradually exhausts the nitrogen supply in the soil around its roots, and then begins to suffer from nitrogen starvation. Under these conditions both growth and fruitfulness are adversely affected. Heavy pruning, reducing the carbohydrate to a level equivalent to the small nitrogen supply, may cause a temporary improvement, but the best results will be obtained by moderate manuring coupled with pruning. The result of pruning in this case is to remove old moribund branches, causing the development in their place of vigorous new shoots, which are much more efficient as manufacturing organs than those removed. In this way the carbohydrate supply is very soon increased, and if the nitrogen supply is increased at the same time by manuring, the tree returns to a fruitful condition.

The physiological balance can be affected in the opposite direction by root-pruning. Often a tree which has been over-pruned or over manured gets into a condition of unfruitfulness coupled with vegetative growth due to excess nitrogen. In such a case root pruning, by curtailing the nitrogen supply, quickly restores fruitfulness, whereas in the case of the old tree suffering from nitrogen starvation the operation would obviously be worse than useless.

The work by which the importance of the carbohydrate nitrogen balance was first indicated was done by two American plant physiologists Kraus and Kraybill, who experimented with tomato plants growing under carefully regulated conditions. It was very soon followed by several investigations on apple trees, carried out by men who realised the immediate application of the principle to pruning. The result of all the work taken together is to show quite clearly that the principle is correct, but that at the same time a number of factors have to be taken into account whenever it is applied.

In the first place, the reverse materials in the tree vary from season to season so that pruning in one month is likely to remove more than pruning in another month, with consequently different results on later growth. The variation is probably less in our tropical crops than in a temperate tree such as the apple, which has well-marked resting period during the winter, but it almost certainly occurs to some extent.

In the second place, the flower-buds will be more affected by the disturbance due to pruning at one time during the course of their development than of another, and in the third place it has been found that a tree which is in ideal condition for producing flowers may not necessarily be in the best condition for setting and maturing fruit. For apples it seems that the fruit sets best when the nitrogen is relatively high. In the ordinary course, the process of flowering, which takes place when the carbohydrate supply is fairly high, itself uses up most of the carbo-hydrate, and so leaves the nitrogen content of the branches relatively high. Thus the right condition for fruit-setting is attained naturally, but pruning at the wrong time of the year may upset matters and seriously decrease the amount of fruit.

To sum up,-the physiological reason for the effects of pruning is largely to be found in the fact that the balance of carbohydrates and nitrogenous substances in the plant is upset This always (except in the case of root-pruning) leads first of all to an increase in vegetative growth at the expense of fruit-production. In the long run, however, fruit production is increased on account either of the extra strength or of the better shape of the tree. (From the Indian Scientific Agriculturist. November, 1925.)