

STARCH DEFICIENCY

A REVIEW OF ITS CAUSES AND EFFECTS WITH SPECIAL REFERENCES TO TYPES OF PRUNING IN THE LOW-COUNTRY

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From recent observations on the types of pruning that are now being carried out in the low-country, it would appear that in many cases adequate attention is not being paid to the main principles which determine the type of pruning best suited to low elevations; in fact, cases are known of Superintendents who, on being transferred from up-country to a low-country estate, have transferred their ideas on pruning with them, and clean-pruned some of their fields, needless to say, with somewhat indifferent results! It has therefore been suggested that a review of the whole question of starch deficiency in the low-country,—and the relative problems in regard to pruning (as investigated by Dr. Tubbs)—would not be out of place.

The 'Diplodia' Disease.—The early publications of the Tea Research Institute show that formerly the widely exhibited complete or partial failure of tea bushes at low elevations to recover after pruning was attributed to a disease known as 'Diplodia'; in 1923 Petch ascribed this disease to the fungus *Botryodiplodia theobromae*, which was invariably found on the roots of such dead bushes.

Starch storage in relation to the 'Diplodia' disease.—In 1928 however, the important discovery was made that the roots of tea bushes store starch, and Gadd traced the connection between the incidence of 'Diplodia' disease and the amount of starch that was stored in the roots of attacked bushes. This placed the 'Diplodia' problem in an entirely new light, and exhaustive tests showed that the roots of bushes which had died after pruning were invariably devoid of starch; on the other hand, starch was present in the roots of healthy bushes, and those which had died as a result of infection by root disease fungi. He therefore came to the inevitable conclusion,—confirmed by subsequent reasearch work—that the primary cause of death of tea bushes after pruning was the lack of sufficient food reserves (i.e. starch) in the roots at pruning time to support recovery; the occurrence of *Botryodiplodia theobromae* on the roots of these bushes was therefore purely secondary,—its invariable presence being explained by the fact that it is one of the commonest fungi found in dead tissues of low carbohydrate content.

The role of starch in the economy of the tea bush.—Before going into any further detail, it is necessary to recall that starch is one of the principle carbohydrates formed in the process of photosynthesis, by which the leaves of plants in the presence of sunlight convert the raw materials obtained from the soil and air into elaborated food materials; these carbohydrates form the true food of all the higher plants, and their presence in plants is essential for growth; thus a periodic buildup of carbohydrates by photosynthesis is accompanied by their constant breakdown in the plants' growth processes.

This state of affairs assumes great significance in the case of a crop such as tea which is periodically pruned; for if tea bushes are left at such times almost devoid of leaves, they are unable to make use of the raw materials necessary for growth, and are inevitably dependent for recovery entirely on the reserves of elaborated foods (i.e. starch) which they may have accumulated.

The effect of elevation on starch storage.—Following on the initial discovery that the problem of deaths of tea bushes after pruning was not a mycological one, but was intimately bound up with the question of starch reserves in the bushes at pruning time, Tubbs made a series of further investigations on many aspects of the problem.

The first of these consisted of a survey of the relationship between elevation and the amount of starch stored by the bushes. This indicated that the total carbohydrate content of bushes increased in direct proportion to the elevation, —bushes at sea level containing an average of 10 per cent. carbohydrate, and those at 7,000 feet an average of 26 per cent. Although these figures do not indicate precisely the amount of carbohydrate reserve that is actually available to the bushes (for use in recovery after pruning), they are nevertheless of great significance, especially as it was found that the bushes which failed to recover from pruning showed a total carbohydrate content of 12 per cent. or less. From this it was evident that tea bushes when pruned must contain a reserve balance over this amount, or no new shoots would be produced, resulting in their partial or complete death.

Although differences in cultural treatment at various elevations—(in particular varying pruning cycle lengths)—may have some long term effect on the carbohydrate storage balance, the probable fundamental cause of the balances varying with elevation is temperature differences, which exert a marked effect on the rate of build-up and break-down of carbohydrates. Thus at low elevations the higher temperatures cause a considerable increase in the rate of carbohydrate manufacture, but this is more than offset by an increase in their rate of break-down,—a process which moreover is continuous and not confined to daylight; in addition the higher soil temperatures tend to enhance the consumption of carbohydrates by the root tissues. In other words, the greater call made on the carbohydrates at low elevations, due to the enhanced growth rate, results in a reduction of their net daily balance (*i.e.* amount of reserve) to a point at which it is insufficient to enable the bushes to develop new growth after a severe prune.

On the other hand at high elevations, the slower rate of growth (*i.e.* a slower rate of break-down of carbohydrates) enables the bushes to build up a higher carbohydrate balance in their roots, which is adequate to enable them to recover from clean pruning.

It follows, therefore, that since the ability of bushes at low elevations to recover from pruning is entirely dependant on the amount of carbohydrate stored in their roots, logical ways of ensuring recovery consist of the following:—

- (1) Modifying the method of pruning adopted, with the object of ensuring that there are enough leaves left on the bushes at pruning time to enable them to continue to elaborate food materials, and:
- (2) Suitable cultural operations before pruning, (such as adequate manuring, and resting of weak bushes as necessary), with the object of increasing the carbohydrate reserve.

The comparative effects of different types of pruning.—With the background to the problem of pruning at low elevations now elucidated it followed that any form of cut-across prune would go far towards giving the desired result; the normal cut-across, however, has the inherent disadvantage that dead and diseased wood cannot be cleaned out, while there is a tendency to leave an inadequate number of leaves on the bushes. An entirely new type of pruning now suggested itself, descriptively termed 'rim-lung'—and a series of tests at different elevations was carried out to compare the results achieved by this method with those of the orthodox

'clean' prune, and 'cut-across' prune. Although in practice these were not completely distinct from each other, differences between them were nevertheless sufficiently wide to enable them to be classified roughly as follows:—

1. **Clean-prune.**—the main frame pruning branches being cut to 3" above the previous pruning level, and nearly all the smaller branches removed.
2. **Cut-across.**—pruned at the same level as for the clean prune, but nothing except diseased wood was removed below that level.
3. **Rim-lung.**—only the centre of the bushes were pruned, at the same level as the others, 6 branches being left on the circumference until 10 days before tipping.

As already stated, experiments with these types of pruning were replicated at various elevations typical of 'low-country', 'mid-country', and 'up-country'; for the purposes of this review, however, we are only concerned with the effects under low-country conditions—the relevant plots being sited on Galatura Estate, at an elevation of 200 feet.

Perhaps the most spectacular revelation of these experiments was the comparison between the numbers of deaths which occurred within 3 months of pruning, under the three systems. Each treatment comprised a total of 1,500 bushes and clean pruning resulted in the death of 67 of the bushes while rim-lung and cut-across prunes resulted in the deaths of 8 and 27 bushes respectively.

It should be added that the plots were chosen for uniformity and, therefore, for healthiness—from which it would be reasonable to assume that the percentage of deaths of the clean pruned bushes would have been far greater on the impoverished areas which are more representative of typical low-country tea.

The other information obtained from these plots is as follows:—

	<i>Clean prune</i>	<i>Rim-lung prune</i>	<i>Cut-across prune</i>
Die-back after pruning (lbs. of dead material per 1,500 bushes)	346 lbs.	130 lbs.	227 lbs.
No. of leaves remaining per bush after pruning	3	201	42
Average diameter of pruned bushes	2.7 ft.	3.5 ft.	3.3 ft.

It is clear that at low elevations, rim-lung is the most satisfactory type of pruning—at least with the systems of bush management adopted at that time, (i.e. when a low prune was in vogue). This method allows all the necessary 'bush sanitation' to be carried out, without any of the disadvantages inherent in clean pruning at low elevations; moreover, its salutary effect on the spread of the bushes is of some importance.

The combined effect of all this was of course evident in the yields obtained under the 3 systems, and the plots which were rim-lung pruned showed a relative increase of over 200 lbs. per acre at the end of the first 2 year cycle.

Following on these experiments in which the 3 main types of pruning were compared, another experiment was carried out at Galatura, to compare the effects of the following:—

1. 6 lungs left on the bushes for 1—2 months from pruning.
2. 3 lungs left on the bushes „ „ „ „ „
3. Clean pruning.

The data from this experiment is summarised as follows:—

	6 lungs	3 lungs	Clean prune
Average number of leaves left per bush	327	203	3
Number of deaths per acre (3,000 bushes)	22.5	28.2	168.6
Lbs. of pre-tipping die-back per 1,000 bushes	110 lbs.	127 lbs.	237 lbs.

As would be expected, the greater rate of growth consequent on leaving 300 leaves per bush allows the lungs to be removed earlier than when only 200 leaves are left (in which case they should be left on until tipping time). The experiment also disproved the idea current in some quarters that the growth of the lungs was prejudicial to the production of tipping shoots in the centre of the bushes.

The final recommendation made as a result of all these experiments was that below 1,500 feet not less than 250 leaves per bush should be left at pruning time.

References

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