THE PRUNING OF TEA IN RELATION TO DISEASE.

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The pruning of a tree is, in horticulture, the equivalent of a surgical operation in medical science. A surgical operation, however, is usually performed primarily to benefit the patient's health, often to save his life. The corresponding operation in horticulture is carried out for grosser purposes; yet, if the maximum benefits are to be derived from it, some consideration of its effects on the general welfare of the tree itself is essential. Before advising a major operation, a doctor would or should first satisfy himself that the operation is necessary; that the patient's health is such that there is a fair chance of his surviving the operation; that the operation is performed under the best possible conditions, and that the best available surgeon is retained for the work. It may be of interest to ascertain to what extent such principles can be applied to the pruning of a tea bush.

We may take it for granted that no planter will prune his bushes unnecessarily. Pruning is a necessary evil, and no one is better aware of that fact than the planter himself. If health were the only consideration, the bush would not be pruned other than to remove diseased or useless branches. The primary consideration, however, is crop, consequently, pruning is carried out with that aim in view. But if pruning is going to lead to losses as a result of the deaths of complete bushes or even of main branches, the main object will be defeated.

That being the case, the health of the bushes at the time of pruning should be such that they have a fair chance of surviving the operation. If health and vitality were measurable as physical quantities, the solution of many biological problems would be considerably advanced, and it would be possible to ascertain whether a tea bush was in a fit state for pruning. At present, health and vigour cannot be measured with any degree of accuracy so we must depend upon observation and experience for criteria. It is a common experience in the low-country to find that bushes which appear vigorous and healthy before pruning fail to make any growth afterwards. That is called the Diplodia disease. The deaths are not due primarily to the attacks of Diplodia or any other fungus; they are the consequence of an insufficient reserve of internal food material. A rest of about two months before pruning would probably enable the bushes to accumulate sufficient reserves to ensure an effective recovery after pruning. The recommendation to rest bushes for such a period raises the question "Is it economical?" The answer must depend upon the

particular case and the state of the bushes. On most up-country estates a rest is not necessary, but in the low-country a rest is in most cases advisable, particularly if "clean pruning" is practised. Where estates are restricting crop, resting the fields about to be pruned probably constitutes one of the best and most economical forms of restriction.

I do not propose to speak at length on the so-called Diplodia disease today. It formed the main topic of my address to you at our First Conference in 1929. I make reference to that disease here mainly as an illustration of what I mean by the bushes having a fair chance of recovery from pruning. Whatever else may be necessary, if the bushes are to be deprived of all or practically all their leaves, they must have an ample supply of internal reserves if they are to survive the operation.

Turning now to the operation itself and the conditions favourable to success, much attention is paid in a hospital operating theatre to its aseptic state. Fortunately, in tree surgery equal protection against pathogenic infection which would militate against success is neither necessary nor possible in a tea field. Through there is less risk of infection at the time of operation, this advantage is somewhat nullified by the fact that the wounds take longer to heal, and so there is a longer period in which infection may occur. The complete healing of wounds is as necessary in the vegetable kingdom as it is in the animal world. In the past very little attention was given to the healing of pruning cuts in a tea bush; it was sufficient to cut off the branch and let the wound take care of itself. The result can be seen in the majority of old tea bushes in Ceylon. Today more attention is paid to the question of healing, and more notice is taken of callus formation.

Healing is a process of growth, and consequently is correlated with general health and vigour. But all wounds will not heal equally well; much depends upon the position of the wound. As a general rule it is safe to say that the closer a wound is made to a growing bud or branch the more readily does the wound heal. In other words, a primary rule in pruning is to leave no pegs. This, to many, may sound like heresy, but in my opinion, the old practice of leaving pegs is fundamentally unsound. If a branch is to be removed it should be cut off flush with the parent stem; if a stem is to be cut back it should be cut close to an eye (bud).

The callus, which should ultimately, completely cover and seal the wound, arises from a small zone near the perimeter and grows inwards towards the centre of the wound. Consequently, the larger the wound the longer the time which elapses before it can be healed.

The callus of tea is slow growing, and some protection against infection by wood-rooting organisms is necessary wherever large wounds are made. The mere fact that callus growth has started affords no protection to the wood yet uncovered. Nor will the presence of a complete callus over a wound stop the decay of the wood beneath it, if that wood has been infected by a wood-rotting fungus before the wound was completely healed. I have isolated from the decaying wood of a tea bush, at a point below a wound which had been completely healed over, a fungus, which on test proved to be an active destroyer of tea wood. Externally, the branch, including the callus, appeared perfectly healthy. The fungus could only have established itself in the wood before the wound was healed. It is to prevent such happening that an artificial protective covering is necessary. This may take the form of tar, tar and wax, white lead paint or a suitable proprietary mixture.

It has been ascertained that under temperate conditions the best time to prune trees is at the end of their dormant period, or in other words, just before their growing period. That rule probably holds good for tea. Tea, however, is an evergreen shrub and has no very fixed times of growth and dormancy. These depend upon weather conditions and will vary with the district.

In theory, one should not prune at the beginning of a dry spell, but in practice one sometimes does. That is for economic reasons which may demand that the maximum number of bushes are in bearing at the time climatic conditions are such as to give maximum crop. Most estates have determined by experiment the best time to prune and there is little need to say more about it here, other than to remind you that the best time for pruning, from an economic point of view, is not necessarily the best time from a pathological view-point. My job today is to emphasise the pathological side.

Amongst the other conditions favourable to success one must include severity of pruning. We know from experience that a biennial clean prune at low elevations frequently results in a relatively high proportion of deaths. I have earlier suggested that a suitable rest before pruning constitutes one way in which such deaths can be avoided. Another is by instituting a lighter form of pruning which leaves a fair proportion of green leaf on the bush. From what I have seen and heard, the growing practice of light pruning is having a marked effect in decreasing the number of deaths following pruning. The popular form of light pruning is the "cut across." Cutting across, however, has its accompanying problems and evils.

There is the bhangi problem amongst others, but I am more chiefly concerned here with pathological problems. Whatever disadvantages clean pruning may have, it enables the bushes to be

thoroughly cleaned. The whole frame is exposed; rotten cavities in the frame can be cleaned out and treated; diseased branches are removed, often before the symptoms of disease are noticeable. Cutting across does not allow of such thorough cleaning, and consequently stem diseases are likely to become more noticeable. The two I have in mind are Red Rust caused by the alga, *Cephaleuros parasiticus*, and the true branch canker caused by *Macrophoma theicola*. I do not suggest that these diseases are bound to occur as a result of cutting across; what I suggest is that in fields liable to these diseases, they will become more prominent as a result of cutting across, because branches in an early stage of attack are not removed by normal pruning. It is possible for some such reason that the Indian Tea Association have for some time recommended the application of a fungicide after pruning.

An increase of what one may term the minor stem diseases of tea is not sufficient to condemn cutting across, as in my opinion the advantages to be derived from such a light form of pruning outweighs its disadvantages, so far as I have seen them at present. It does, however, raise the question whether it is advisable in certain fields to continue cutting across more or less indefinitely without a periodic clean pruning. The interval between clean pruning will depend upon the condition of the frame and the amount of disease occurring on the branches. I recently saw some fields which were clean pruned every eighth year, the bushes being cut across in alternate years in the interval. The system appeared to be highly successful. As only one-eighth of the estate is clean pruned annually, more attention can be paid to the frames of the clean pruned bushes than is the case where clean pruning is the general routine practice. This system is worthy of consideration. Some fields may run for more than eight years, others less, between clean prunes—no hard-and-fast rule can be applied.

In general terms, light pruning is preferable to hard pruning, from the point of view of disease, but that does not mean that all hard pruning is necessarily bad. There are occasions when collar pruning is necessary, but in all such cases it is advisable to rest the bushes for a period before the operation.

Tea bushes up-country appear to withstand heavier pruning than bushes in the low-country. I am not sure that in all cases this difference is a result of internal food reserves. It may be partly a result of climatic conditions, but I am more inclined to the view that it is a question of jât, and that a high jât bush will not withstand such heavy pruning as a low jât bush, other conditions being equal.

And now a word on the Surgeon—the Tamil Cooly. He certainly has no academic qualifications; he knows little about the

anatomy or the physiology of a tea bush, and one commonly regards his intelligence as being not of the highest type. Yet in spite of all these handicaps, if the lack of a scientific degree may be regarded as a handicap, he carries out his job creditably and merits considerable praise. But it is not to be expected that he will treat every bush rightly according to its merits. He must work to simple rules; perhaps, that is why it is better for him to get his instructions from a planter than from a scientist. He is told to prune to a level or to make his cuts a certain distance above the last pruning cuts. The scientist may say 'Prune close to an eye or bud.' The latter may be theoretically more sound, but the former is more practical. For one thing, the cooly would probably not recognise the buds on much of the wood he prunes into, and if he could, his task would have to be considerably reduced if he had to make his cuts close to vigorous buds. On the other hand, if wounds are to heal readily they should be made near the buds and not at a distance from them.

Does healing matter ? I think so, if the frames of the bushes are to be preserved. An open wound is a danger whether it be on animal or tree. The rotting cavities so frequently seen in tea bushes are the direct results of infection through wounds—most frequently pruning wounds. The natural preventive against infection is healing—artificial covers are but a temporary measure.

I suggest that the best method of meeting this point is by means of a 'secondary' prune. A certain amount of dieback is to be expected after pruning—the amount will depend upon climatic or other conditions but a certain amount, taking a field as a whole, is almost certain to occur. Such diebacks are best pruned out early. In addition to cutting out diebacks the secondary pruners also remove all snags and pegs left by the original pruners, and make the cuts as close to growing shoots as is possible without injuring the shoots. The pruning cuts then would be in the best position for healing, and callus growth would be more frequently observed in the tea bush. I submit that this suggestion is not impracticable but it is not the work for an average pruner. It is work for the most skilled pruners. It can be done any time after the new shoots have started growth and before tipping. The secondary prune applies more to clean pruning than to cutting across.

In conclusion, I would point out that there can be no one method or type of pruning applicable to tea in all districts under all the varying conditions of climate and elevation. There are, however, certain principles which underlie the operation and which should be taken into consideration when deciding upon the pruning treatment of any field. I have here attempted to indicate a few of them. The pathological problems associated with pruning do not admit of

solution by curative treatment; prevention is the key word and I submit that closer attention to the principles I have outlined here, would do much to prevent the occurrence of unsightly cankers and eliminate many of the losses so commonly associated with pruning.

DISCUSSION.

Mr. John Horsfall, in opening the discussion, said that they had listened to what he considered to be the two most interesting papers he had had the good fortune to hear in this country. The papers were most instructive and after listening to them, planters must have come to the conclusion that there was still something to learn about pruning. The papers certaintly gave food for thought and for argument.

The question of 'recovery' had been studied to a very large extent in the low-country by progressive and thoughtful planters who had taken warning from the colossal number of casualties. There they had adopted a system of 'cut across' in various forms, and that system was now undoubtedly creeping up-country. Up-country, however, the conditions were rather different from those at lower elevations. Generally speaking, the low-country planter, to his misfortune, was unable to deal in much else but quantity. Up-country they strove for quality, and it may be that on this they would have to hang their hats in the present state of affairs.

He had no doubt of the efficacy of the cut across as regards recovery, but he wondered whether it was advisable up-country, because of its possible relations with the question of quality. Apparently, 'cutting across' altered the distribution of yield in the pruning cycle, but the scientists were not prepared to say what would be its effect on quality. Where quality was the main objective, cutting across might have disadvantages. It was generally held that real quality did not come in during the first year from pruning and it was arguable when it did come—perhaps the second, third or fourth year. If so, their pruning then had to last that period.

It appeared to him that a half-way house between the two methods, cutting across and clean pruning, was required, and possibly 'lung pruning' might prove the answer. The system of leaving 'lungs' or 'flags' was not new, but was a reversion to an old type of light pruning. One remembered the time when an 'umbrella' was left in the middle of the bush to help it to manufacture its carbohydrates. Further this lung method gave an opportunity of pruning to an outer eye. Pruning to an eye throughout would be costly as the pruner's task would have to be reduced to 50 or 60 bushes. The method he advocated was to leave the 'lung' with too much on in the way of leaf rather than with too little. The lung could easily be taken off later by the secondary pruners. With him the secondary prune was done by the tippers at a cost of about 6 to 8 coolies an acre, and the work became cheaper as the coolies became used to it. He had the 'flag' or 'lung' pruned back to an eye, which had sprouted. The length of the branch left might be rather long but the plucking table grew up to it and there was no dieback. If no eye developed he left the flag till next pruning time by which time it usually developed. He had noted that his system gave very good callus growth on the wounds.

A further advantage of this method of pruning was in its relation to pruning mixtures. He had discussed this question with Mr. P. A. Keiller as far as the dry zone was concerned. There they did the pruning in July, August and September, and he gathered that Mr. Keiller's original idea was to apply the pruning mixture in April or May in order to get the bush in good vigour before pruning. If one applied the mixture at pruning time or just after pruning when

the bush was barcheaded and left with no 'lungs,' how was the bush to make use of the mixture even if the nutrients were readily available ? It was an extraordinary difficult problem and the further one delved into it the more complex it became, but it seemed to him that 'lung' pruning got over that difficulty.

Since adopting lung pruning he had noticed a marked improvement in his 'so-called' Witches Broom patches, the disease having disappeared entirely from some. His losses from pruning were at one time alarming, but now they were negligible. He was not prepared to attribute this improvement solely to lung pruning as he had experimented with other treatments also. He had tried flowers of sulphur, sulphate of iron and individual manures as well as eliminating dry weather pruning. He would not deny that applications of potash and the elimination of dry weather pruning were also contributery causes of this improvement.

That brought him to the question of dry weather pruning. He had arrived at a stage extraordinarily near Dr. Gadd's suggestion to prune at the beginning of a growing period and not at the end of it. He had so diminished his acreage of dry weather pruning that not more than one seventh of the estate was pruned during the dry period, and as a result die-back was diminishing markedly. Complaints were sometimes made that this meant a sacrifice of flush during the best period of growth. That however was not his experience. He had now carried out this system in increasing percentages over five pruning cycles—not five years —and one could by five cycles more or less eliminate climatic and individual vagaries. His experience amply justified the change from dry to wet weather pruning and he had experienced no loss of crop.

Mr. Horsfall again referred to the value of the secondary prune and said that for the work he used a special very light knife. It was double handed but had only a two-inch blade. He had found this to be a very satisfactory tool.

In conclusion, he asked Dr. Gadd whether he had come to any conclusion regarding the best time to adopt a 'sanitary' prune.

Dr. Gadd replied, after ascertaining that the 'sanitary' prune was used to indicate the clean prune after successive 'cuts across,' that the best time would vary in the different districts. As a fundamental principle he would select the beginning of a growing period when the sap was beginning to move rather than a time of dormancy. He would prefer wet weather to a drought.

Mr. Huntley-Wilkinson asked what were the gross yields from the fields normally pruned and cut across, on the estates discussed by Mr. Tubbs.

Mr. Tubbs replied that he regretted that the precise data were not in the conference hall at the time.

Mr. Wilkinson said that the cut across treatment on the Dimbula estate resulted in an increase of 300 lb. per acre above the previous cycle, which was normally pruned. A complication was introduced by the application of 16 tons per acre of cattle manure in the cut-across cycle extra to the manures it had received in the previous cycle.

Mr. Tubbs said that on examination of the manuring programme of the estates he had discussed, it appeared that the earlier development of the maximum yield in cut-across fields was an effect of the type of pruning, although manuring might emphasise or decrease the difference.

Mr. Morford asked whether in bringing young clearings into bearing it was better to centre as late as possible, since it had been stated that pruning decreased root growth. He further asked for details of the elevation of the estate quoted by Dr. Gadd.

Mr. Tubbs replied that it was not known whether root growth was on the whole retarded to a greater extent by gradual pruning or by a severe cutting.

Mr. J. Horsfall said that in his experience a gradual thumbnail pruning gave a shorter but thicker taproot.

Dr. Cadd said that he could not give the exact figures of the estate referred to, but the elevation was roughly about 2,000 feet. As regards leaving young plants in clearings as late as possible before centreing, he pointed out that this meant, as a rule, making the first cut on fairly thick wood. It was a common experience in the low-country to be able to push a walking stick for some distance down the centre of the main trunk of a tea bush owing to the rottenness of the wood. The origin of this wood rot could probably be traced to the centreing operation. Thumbnail pruning, while the plants were seedlings, tended to induce low branching and to some extent removed the necessity for centreing. He would like from the disease point of view to see heavy centreing cuts avoided. He advocated the application of the secondary prune to centreing so that the final cut was made close to a shooting bud. In that way adequate callus formation would be induced, and the risk of wood rot setting in from the first cut minimised.

Mr. Carson-Parker referred to a system of pruning in India in which the men do the first prune and the women the second. He asked if Mr. P. H. Carpenter could give further details of it and tell them about pruning in general in India.

Mr. P. H. Carpenter, (Chief Scientific Officer of the Indian Tea Association) said that a distinction must be made between the cases described by the readers of the papers and the North Indian practice, since in North India pruning was annual and confined to the non-growing period. In Assam, growth finished in November and there was a non-growing season during December, January and February when the bushes were dormant. Pruning was done during that period.

As regards the Bagjan pruning referred to by Mr. Tubbs one must bear in mind that it was an annual prune. He had never seen it successful when anything more than one year wood had to be cut. The method was to remove practically all the new growth of wood and this produced the effect of pollarding. It was simply a system of cutting away new wood, and its object was to avoid cutting back. It was not adopted as a general system in Northern India, but he had seen areas which had been Bagjan pruned for twenty years. The bushes were giving a steady crop but they had lost their sides and become narrow. They consisted mainly of great central upright stems with a large knob at the end. Their spread was inadequate and afforded little cover for the ground.

Reference had been made to pruning experiments at Tocklai. At the beginning of the experiments the areas which were pruned biennially gave considerably more crop than those which were pruned each year, but as time went on they no longer showed this advantage, and today the annual pruned plots gave higher yields than those pruned biennially. This might have nothing to do with the actual time of pruning, as with a biennial prune older wood was being cut than was the case with an annual prune. They found that the wounds from a biennial prune did not heal quickly enough to prevent the introduction of disease spores into the wound, whereas the wounds made during annual pruning healed readily. For that reason annual pruning was preferred in Northern India as this meant cutting on only twelve months' old wood which healed rapidly. In this way they avoided the trouble which Dr. Gadd had warned them about that day.

With regard to the relationship between quality and pruning he was not in a position to say anything very definite except that the higher and longer the old wood was on the bush the slower was the growth and the better the quality. When they cut back and had vigorous new growth on the bush they lost quality. With collar pruning it was doubtful whether they got back the quality in under ten years; certainly not in under six.

The losses from heavy pruning, such as collar pruning were very great. It was not merely a question of immediate losses, which might be as severe as 40 per cent., but of the subsequent losses also. If a section were collar pruned or cut back to about twelve inches from the ground one might find on counting the deaths in that section over a ten-year period that at the end of that time the entire area had been replanted. The lighter the pruning, the better it was for the bush.

In conclusion, Mr. Carpenter said that he had to differ with Mr. Horsfall on one remark he had made. Mr. Horsfall had said that the papers they had listened to had given food for thought and food for argument. Mr. Carpenter agreed that they had provided food for thought but not food for argument.

Mr. L. B. Creen asked whether nitrogen could be absorbed by the plant in the absence of foliage leaves.

Mr. Tubbs replied that there was no definite information on that point.

Mr. Holland recalled that an objection was raised to a proposed pruning experiment at Peradeniya on the ground that since yield was affected by many other cultural factors besides style of pruning, an experiment on pruning alone would be useless.

Mr. Tubbs replied that a very large number of factors were concerned in the growth of the bush, but that he did not agree that the investigation of the major factors should therefore be abandoned. An attempt to include even a fair proportion of the relevent factors in a field experiment on tea, if it were properly designed, would result in an experiment of a size that would be quite unmanageable. He referred to Mr. Eden's finding that 4½ acres a day was the limit of experimental plucking.

Mr. Eden confirmed this.

Mr. Wilmot Perera asked whether the forking in of prunings with the pruning mixture would enhance the danger of root rot, and whether the burial of pruning mixture with the prunings had any beneficial effect other than would be derived from the actual cultural operations applied separately.

Dr. Cadd replied that there was very little risk of root disease resulting from the burial of prunings if large wood was not buried. He would advocate the practice rather than condemn it, as the benefit to be derived from the incorporation of green material into the soil was immeasurably greater than the risk run from the introduction of disease by that operation, provided the larger and thicker wood was not included. He referred the second question to Mr. Eden, the Agricultural Chemist.

Mr. Eden replied that it was rather difficult to disentagle all the factors which were operating when a pruning mixture was applied and to differentiate with any great accuracy the effect of the forking alone, *i.e.*, the cultural operation, from the effect of the manure in providing nutrients for the bush except by careful experimentation. This question might well form the subject of later experimentation on St. Coombs. As regards the burial of a pruning mixture with the prunings, the former helped in the decomposition of the latter. The use of the two jointly was mutually beneficial.