THE COMPETITION FACTOR

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Competition between individuals of the same or different species is an ever-present factor in Nature. Thus side by side with the advantages resulting from community of shade tree, tea bush and cover crop there exists competition between them for light, water, nutrients and carbon dioxide. Cultural practice is directed towards maintaining a balance favourable, on the whole, to the tea. But the existence of severe competition between individual tea bushes is accepted. The reason for this is that, generally speaking, a high bush number per acre is associated with high yield. This occurs even though the yield of individual bushes is reduced by competition and is due to the more efficient use of soil resources, the more complete protection of the soil from exposure and erosion, and the greater acreage of plucking surface obtained.

It is only when maintenance of the high bush number per acre is attempted that difficulty arises. The competition of old bushes is perhaps the most serious of the adverse factors in the environment of young supplies, and it is enhanced by close spacing. Though this is commonly recognised, full weight is not always given to its importance nor to possible methods of reducing its severity. The following data illustrate certain aspects of the problem. They are derived from an experiment upon supplying commenced in 1937 and terminated in 1941 owing to the war; the data are, therefore, less complete than might be desired.

The experiment was designed to compare the growth of two-year-old seedlings planted in land from which old tea had been cleared, with the growth of similar seedlings planted amid old tea, with a view to estimating the possibility of drastically increasing the bush number per acre without recourse to replanting.

The comparisons were between :—

(a) Normal replanting — 3 ft. × 4 ft. (3,630 seedlings per planted acre) in cleared plots.

(b) Close replanting — 1½ ft. × 4 ft. (7,260 seedlings per planted acre) in cleared plots.

(c) Interplanting of collar-pruned tea— Along the lines of old tea, which was collar-pruned, (3,630 old

bushes and 3,630 seedlings per planted acre).

(d) Interplanting of clean-pruned tea—As for (c) but with the old tea clean-pruned at 16 inches.

The subsequent growth of the seedlings in the four series of plots affords a measure of the competition experienced from mature bushes pruned with differing severity and also from other seedlings of the same age. Again, the percentage of living seedlings in each year provides a measure of the extent to which competition affected the establishment of the young plants.

The proportion of living seedlings at the end of each of the four years are shown in Table I. The plots were supplied annually during the South-West Monsoon.

TABLE I

Percentage stand of young plants achieved with annual supplying.

Years from planting	Percentage Stand				
	(a) Normal replanting	(b) Close replanting	(c) Interplanting collar-pruned tea	(d) Interplanting clean-pruned tea	Significant difference
1	90.7	90.1	86.5	71.0	6.4
2	95.5	95.1	89.9	78.8	2.9
3	97.0	97.4	91.7	75.5	3.6
4	98.9	98.9	97.5	90.8	1.6

Comparison of the data for treatments (a) and (b) (columns 2 and 3) indicates that competition between stumps planted eighteen inches apart did not become sufficiently severe during the period of observation to adversely affect their establishment relative to stumps planted three feet apart in the row. This was true even of supplies put out in the presence of established seedlings planted two or three years earlier, as is illustrated by the close agreement between the two sets of figures for the third and fourth years.

In contrast to this, stumps planted amid established bushes [treatments (c) and (d) *versus* (a) and (b)] were at once subject to sufficient competition to reduce establishment. The deleterious effect of the presence of the old bushes was, however, affected by their pruning treatment. Thus the young plants showed a markedly better establishment amid collar-pruned bushes than in the presence of clean pruned bushes. In view of this, it is probably safe to attribute the marked improvement in the percentage stand in the (c) and (d) plots in the fourth year to the second pruning of the mature bushes in these series at the end of the third year. That competition increased as the mature clean pruned bushes reached the end of their cycle is indicated by the reduction in stand of young plants from 78.8 per cent to 75.5 per cent in the third year of the cycle. The latter value, though not significantly less than the former, is significantly less than the value to be expected had this series of the plots shown the same average increase in stand in the third year as did the other three series.

As competition may effect the growth of young plants without actually causing death, their growth rates provide more delicate measures of the competition suffered. The growth index chosen was the rate of increase in diameter of the stem at ground level, measurements being made at six-monthly intervals. Unit increase in diameter represents the addition of widely differing amounts of new tissue where stems differ in diameter. The average increase in cross-sectional *area* of the stems every six months has therefore been calculated, the means for each treatment being shown in Table II.

This is the state of affairs that may be assumed to have developed in old tea, since clonal plants have been demonstrated to develop in five years roots of sufficient radius to fully occupy the area of 12 square feet of soil allotted to each plant. The old bushes in the experimental area under discussion may be assumed, therefore, to have developed root systems of as great volume as possible under the local conditions of soil and cultural treatment. It is not surprising, therefore, that the growth of the young plants in both the interplanted series showed the effects of competition relatively early, nor that the accumulated effects led

TABLE II

Growth of stem at ground level.
(Mean increase in cross-sectional area)

Six monthly period from planting	Mean Increase in Square Inches × 100			
	(a) Normal replanting	(b) Close replanting	(c) Interplanting collar-pruned tea	(d) Interplanting clean-pruned tea
1	0.2	0.3	0.3	0.2
2	2.8	2.9	2.8	1.5
3	4.3	4.3	3.3	0.5
4	14.7	13.0	8.7	1.6
5	26.7	21.9	9.0	0.3
6	16.5	13.1	7.8	1.3
7	6.2	11.0	7.5	2.1
Periods 8-18 (Average)	30.1	20.1	6.2	1.1

Considering firstly competition between young plants, it is apparent from the two columns (a) and (b) that its effects were not apparent until the fourth period. Further, its influence thereafter was relatively slight. This was doubtless due to competition between the plants within each row being mitigated by the presence of areas of as yet untapped soil between the rows. Not until the fertile layers of the soil are completely permeated will root competition reach its maximum.

to a very marked reduction in the total growth by the end of the 7th period of observation.

It is again apparent from Table II that the treatment of the mature bushes profoundly influenced the degree of competition to which the young plants were subjected, collar-pruning providing distinctly more favourable conditions for the growth of the young plants. It is again possible to distinguish the effect of the pruning of the mature bushes during the sixth period, the

growth of the young plants showing a distinct improvement relative to that of those in the replanted plots.

mature tea appears to last between six and nine months, while the data shown in Table II suggest that competition from the collar

TABLE III

Annual Growth in thickness at ground level relative to that in the preceding year.

Period	(a) Normal replanting	(b) Close replanting	(c) Interplanted collar-prune	(d) Interplanted clean-prune
4-5	5.8	4.8	2.9	1.0
6-7	0.5	0.7	0.9	1.8

The latter effect is even more marked when relative increases in cross-sectional area are compared, instead of absolute increases. For example, if complete years before and after the pruning in period six are compared in order to eliminate seasonal effects; the results shown in Table III are obtained. From showing the smallest increase in relative growth, the interplanted series showed the largest after their competitors had been pruned.

The interest of the relatively better growth of the young plants in the interplanted plots compared to that of those in the replanted series in periods 6-7 is enhanced by the fact that they were all centred 2½ inches above the collar at the same time as the mature tea was pruned. This difference in growth occurred in spite of the fact that centring must have prevented full advantage being taken of the period of decreased competition from the mature tea. It suggests the possibility of some form of 'trigger' effect, leading to the utilisation of reserve materials available in the plants whose growth had been checked by competition, but not in freely growing plants.

The reduction in the effects of competition following upon clean pruning of the pruned bushes may not have reached the maximum even after three years. It is difficult to believe that the agency through which competition acts was, under the conditions of the experiment, anything affecting the aerial portions of the bush. Tea tolerates shade and young plants are capable of growth under conditions of far heavier competition for light than occurred in the experiment. Nor is there any reason to suppose the supply of carbon dioxide to have been less in the vicinity of the young plants. One is forced, therefore, to the conclusion that the effects that have been discussed are due to root competition. Such root competition will be for water and for nutrients. The 'trigger' effect postulated above may well be influenced by an increased availability of minerals subsequent to reduction in the severe competition previously experienced from the mature bushes. This would enable the utilisation of the relatively abundant reserves of carbohydrates commonly found in plants starved of minerals.

The experiment provides further evidence in support of the view that pruning, as commonly carried out on estates, materially reduces the absorptive capacity of the roots. The clean pruned mature bushes were

tipped approximately five months after pruning, on both occasions. As root competition was reduced for six to nine months, it would appear that the root activity of pruned bushes had not returned to normal at the time of tipping unless, as is possible, the operation of tipping again checked root activity. The practical application of this point in relation to manuring procedure has long since been emphasised in connection with the results of the Institute's manurial experiments.

Turning to the other practical applications of the information provided by the experiment, the conclusion is unavoidable that it is not feasible to increase drastically the bush number per acre by interplanting existing tea unless the latter were to be collar-pruned, or other drastic measures were taken to reduce root competition. The practice of "isolating" young supplies by severing invading roots is one method of achieving this, but it is suggested that the roots of the mature tea should be severed at a greater distance from the young supply than is commonly the case. One and a half to two feet is probably not excessive. Again, special applications of manure to supplies are frequently made. These will best serve their purpose when applied simultaneously with, or immediately after, the pruning of the old tea, the supplies being left unpruned. A corollary to this is, of course, that if the supplies have to be pruned, it is better to prune them some months before the rest of the field, so that full advantage may be taken of the period of reduced competition from the mature bushes.