

SHADE OR NO SHADE FOR ARABIAN COFFEE

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THROUGHOUT the world the question of shade for coffee has been the cause of controversy among coffee planters, and among the research or overall authorities who guide or control the various coffee industries. It is only in recent years that research has been able to simplify the problem and give guidance to those who plant coffee. Mr. Haarer lends some support for the theory for shading Arabian coffee, but at the end of this article we have printed a note, extracted from the *Information Bulletin*, Inter-American Institute of Agricultural Sciences, which advocates a no-shade theory for nursery seedlings, at least under the conditions that prevail at Turrialba, Costa Rica.

It is well known that Arabian coffee originated in the shaded, forest-clad valleys of Southern Ethiopia, where it is found fringing streams and in forest glades. It sprawls or grows into a tall and slender tree in its efforts to reach the light, and the more light it is given, up to a point, the heavier the bushes have appeared to yield. It is unfortunate that when cultivated coffee grows in full sunlight it often overbears its strength and afterwards suffers disastrously from exhaustion.

Research has shown that when the leaves are exposed to intense light the stomata or breathing pores close; hence assimilation and the manufacture of carbohydrates are seriously retarded. At low altitudes in East Africa the stomata of exposed leaves close on bright days as early as 9 a.m. and do not open again until late afternoon.

This accounts for much of the trouble. Intense light encourages over-bearing and then makes it difficult for the plant to manufacture enough food to maintain itself and mature its fruit at the same time. This knowledge helps to prove that the Arabian coffee tree is one that prefers a subdued light or, in other words, a partial shade in those regions where the sunlight is intense. Of course, the effects would be far greater if every leaf of the tree were exposed at the same time. In fact, only a proportion of the leaves are exposed at any time, for the foliage creates shade for the lower branches or for the eastern side of the tree as the sun moves west. Even so, the proportion of leaves affected are enough to tip the balance unfavourably when a tree is bearing its crop.

For those reasons the general advice in East Africa is to give shade below 5,000 feet and to grow coffee without shade above this altitude, except at the highest altitudes in special circumstances where shade is again necessary for another reason, i.e., to protect the coffee trees from the cold night air.

The reason why coffee does not require overhead shade in East Africa at the higher altitudes is because the rainfall is more evenly spread, there is more cloud and mist, and hence, the light is not so intense. It is not, it seems, a question of air temperatures so much as light intensity, although shade at the lower altitudes does help to steady and lower the temperature of the air surrounding the coffee trees. This also is important because Arabian coffee grows best in a temperate climate without frost.

The questions of soil moisture and soil temperatures have their part to play, more particularly subsoil moisture, but first it is necessary to return to shade density. The fact that coffee grows so well in several other parts of the world without shade is undoubtedly due to the environment as a whole; to a light intensity which is less, or to a heavier rainfall and cloudy weather during the cropping and growth periods, which help to annul the effects of the brighter light during the resting periods.

Shade Density.—

Shade should never be dense and it does not seem to be necessary before a coffee tree begins to bear fruit, hence overhead shade can grow up with the coffee if it is planted at the same time. Except at planting time to prevent wilting, temporary shade

should be dispensed with because several authorities have proved that competition for moisture during early growth is more harmful than exposure to sunshine. It is soil shade that is needed in the form of a mulch.

The shade trees should be of a kind that grow fast, have a long life, a feathery foliage and are easy to lop or prune. They should have a spreading growth, and they are best planted in lines across the path of the sun and so widely apart that their branches, when full grown, do not inter-

lace. They are required to throw shadows across the field during the longer hours while the sun rises to its zenith and then declines in the afternoon.

Altitude is not a good guide, for an aspect facing the afternoon sunshine may require a little shade above the 5,000 feet level, whereas a plantation at a lower level facing the rising sun may not need shade at all. Common sense must be brought to bear on the question when the reasons for requiring shade are known.



Fig. 1.—An unshaded high altitude coffee plantation in Kenya. The soil between the coffee trees is mulched with grass and this is cut from every piece of land available on the outskirts of the coffee fields. An opportunity is given to apply fertilizers to the grass rather than to the coffee.

Shade can have an influence on flowering and yield. A light shade need not depress yields, but a little more shade will begin to have an effect. Flower initiation is not so plentiful, the coffee leaves grow larger and the internodes longer the more shade is used. Shade, therefore, can be a means of regulating the yield and, to a certain extent, the time of ripening. The pruning of shade trees should have almost as close and careful attention as the pruning of the coffee trees.

Pests, such as the berry borer and some species of leaf miner, are encouraged by too

much shade and shade trees which are susceptible and act as hosts for mealy bugs and other pests which attack coffee should not be planted on an estate.

Since the shade trees must be of a kind, and planted at a distance apart so that they will not shade a coffee tree the whole time, a properly planted field, in actual fact, is open to a good deal of sunshine. On account of the constant movement of the sun and leaves overhead, and of the coffee leaves themselves disturbed by the movement of the air, no part of a leaf

is shaded for very long or in sunshine for long enough to do harm.

Soil Shade.—

It does happen, therefore, that the soil of a shaded plantation still needs extra shade, especially when the plantation is young, and in those regions where the rainfall is short and there is likely to be a moisture deficit in the subsoil. The shade may be of a kind that will drop ample litter, but if it does not then a grass mulch will be beneficial.

A mulch becomes imperative to obtain best yields and maintain the health of the trees whenever coffee can be grown without overhead shade. Even where the light is not too intense, the soil temperatures can rise too high during sunny days. A mulch keeps the soil cool, it preserves the microflora and conserves moisture. By its gradual decay it helps to maintain the fertility of the soil.

Species of Overhead Shade.—

Not only must a shade tree have all the attributes already mentioned, but it must be one which harmonizes with the coffee in the environment where it is planted.

Some trees, even those of the legume family, appear to be antagonistic and harmful to coffee no matter what the environment happens to be, hence it is unwise merely to thin out a forest and leave indigenous trees for shade without exercising a choice and knowing beforehand what the result will be.

Moreover, having found a shade tree which harmonizes with coffee in one country, it may well be found that the same tree will not harmonize with similar coffee elsewhere. A shade tree that prospers in one country will not always grow healthily in another.

It is this, of course, that has led to such confusion and has heaped fuel on the controversies of the past. It is generally a question of soil moisture and temperatures, principally the former.

The ideal shade tree has a rooting system and make-up which does not rob the coffee trees among which it grows of too much soil moisture or soil nutrients. Yet, in a region where the rainfall is short and the soil of a particular kind, it may well do so. Or the tree may not prosper.



Fig. 2.—A shaded coffee plantation at low altitude in Kenya. "*Cordia holstii*" is the tree often favoured. Note the open shade. The trees are trained to the single stem method of pruning.

When it has been decided that overhead shade is necessary, it then becomes imperative to choose a tree which will succeed and agree with the coffee in the environment concerned. Guidance given by a local research station may not be sufficient if the plantation in question is sited on a different kind of soil, a different aspect of a mountain slope or where the conditions are not the same.

The author has seen unshaded unhealthy coffee at a low altitude in which odd specimens of the sausage tree, *Kigelia aethiopica*, and other indigenous trees stood. Against the trunks and beneath the dense shade of the heavily leaved sausage trees the coffee trees were healthy, but beneath the shade of the other trees the coffee was dead and dying.

Albizia lebbek appears to grow well as a shade tree in India, and the Lamtoro, *Leucaena glauca*, grows well in Indonesia, yet these trees are useless in most coffee regions of East Africa. They grow stunted with abundant seed pods and refuse to make good growth. Many of the *Erythrina* species do well in other parts of the world, whereas in East Africa they are attacked by grubs which bore into the young growths and prevent the trees attaining a suitable size.

The *Grevillea robusta* is not a suitable tree in shape and it competes too severely for the moisture supply in regions of short rainfall. Each tree must be decided upon according to its merits and behaviour in the differing environments of the coffee world. Many a planter has found that his coffee has done better without a particular kind of shade tree and he has assumed from this that his coffee did not require shade, whereas, had he tried another kind of tree or regulated his shade in the proper manner, he would have had a different tale to tell.

Doubtless in Brazil, despite the possibility that the light intensity may be less, the coffee there would be better with a light shade of the right kind, if only to aid in preventing the rapid deterioration of the soil and the premature ageing of the coffee trees. One would have thought they would give some protection from the frosts that do so much damage to coffee in that country.

Even though the guiding rules are known, there is still a lot to discover and argue about as to the best kind of shade for each local-

ity. One is sorry for the planter who is opening up land in a new region where, on account of light intensity and warm temperatures, he is convinced that shade is necessary. One can only advise him to observe the effects on coffee of any local trees that appear suitable for shade.

Moreover, he may list the commonly used shade trees of the world and their attributes. Having decided to narrow his list he may then obtain all the information possible about the rainfall, temperatures and soils of the regions where these trees grow well and compare them with those of his own locality. In this manner he may improve his chances of success.

Generally speaking, where the rainfall is dependable and about 60-80 inches per annum, where temperatures do not rise much above 80° F. and the soil is fertile, well drained, but retentive of moisture, most of the best shade trees will thrive and grow well with coffee. It is where the rainfall is erratic and short, where temperatures are higher, and the soil easily dries out, that some of the best-known and more valuable shade trees are difficult to introduce among coffee. It is time that the requirements of each shade tree were listed along with attributes or shortcomings.

Summary.—

It is described how light intensity is a factor ruling the necessity for shade; also how shade may ameliorate conditions and assist in maintaining fertility in regions where intense light is correlated with erratic rainfall and warm temperatures. The density of shade is discussed and how this may regulate crops. Several reasons are given for the controversy about shade which has persisted for many years, and how shade trees of different species may harmonize or not with coffee in different environments. The attributes of shade trees are mentioned and of how a species may prosper in one country but not in another. It is pointed out that there is insufficient data about the environmental requirements for most of the shade trees commonly used in the world.

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But in Costa Rica.—

The cultivation of the coffee tree under shade is based, almost entirely, on empiric results rather than on scientific studies. The fact that the coffee plant, in its natural habitat, grows under shade is interpreted as a need for such a condition for its better growth. There has not been any careful study to demonstrate this necessity or to explain why the coffee plant cannot grow under direct sunlight.

These ideas have been exposed in the introduction of a thesis presented by Armando Huerta, Bolivian student who entered the Inter-American Institute of

Agricultural Sciences, Turrialba, Costa Rica, in 1952 and made studies of coffee physiology under Dr. Paulo de T. Alvim, Professor of Plant Physiology at the Institute. In his conclusions Huerta states that the physiological reaction of the young coffee plant to the stimulus of light was considered as one of a direct sunlight plant, inasmuch as photo-synthesis and the "proportion of relative growth" were gradually increased as light intensity increased. If the reaction was similar to that of the shade plant, the "efficiency of assimilation" and the "proportion of relative growth" should reach its maximum and then remain constant or decrease before the maximum light intensity is reached. The plants grown under direct sunlight had more dry weight, larger roots, more leaves and a larger number of stomata per leaf and per unit of leaf area.

The author considers that these results indicate that under the conditions at Turrialba the coffee nurseries should be maintained under direct sunlight, due regard being paid to the control of *Colletotrichum* and *Cercospora*, both of which seem to be intensified by sunlight.

NOTE:—Recommended nursery practice for the Territory of Papua and New Guinea includes removal of shade for "hardening" of the seedling prior to planting out—See *Papua and New Guinea Agricultural Gazette* Vol. 8, No. 2—Editor.