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EDITORIAL

INTEGRATED CONTROL OF PLANT PESTS

For nearly two decades, Entomologists have been using the term 'integrated control' in their learned discourses, when referring to the control of plant pests. The concept was developed by Professors Ray F. Smith and William W. Allen who endeavoured to draw on all possible factors affecting pest populations in order to reduce damage to crops caused by pests, from the economic stand point. Professor Smith equates 'integrated control of pests' with 'good Entomology'. Integrated pest control involves the use of ecologically sound principles and economically acceptable techniques in order to control populations of crop-destroying pests and bring them under a reasonable degree of management. In this number of *'The Tea Quarterly'* we are priviledged to publish the Founders' Memorial Award Lecture delivered by Professor Ray F. Smith, Professor of Entomology and Parasitology, of the University of California at Berkeley, to the Entomological Society of America at Los Angeles, California, on the 29th November 1971.

It is of particular relevance to our readers because classical examples with tea in Sri Lanka are used to illustrate some fundamental principles of plant protection in tropical and subtropical areas. He recalls the classical instance of the biological control of the Tea Tortrix Caterpillar using *Macrocentrus homonae* by the Tea Research Institute of Ceylon, and its near reversal by the use of powerful insecticides some years ago, to control the Shot-hole Borer of tea, *Xyleborus fornicatus,* and the ecological debacle that followed. The rise of populations of the leaf-eating caterpillars *Ectropis bhurmitra* and *Buzura strigaria,* and the imbalance in mite populations are vividly recalled.

When developing countries attempt to stage a green revolution to maximize agricultural production, it is important to keep ecological considerations in mind when attempting to control plant pests. Most developing countries are in the tropics or subtropics, where there is no winter, to impose its natural control on pests. Good Entomology is therefore particularly important to countries in the tropics, most of which appear to have made some mistakes in the past by being over anxious to achieve 'total' control of pests in order to save their crops. Professor Smith points out the grave dangers of such a practice and makes a plea for rationality in pest management.

Fertilizer for tea in Sri Lanka

Fertilizer in one form or another has been applied to tea in Sri Lanka for several decades, long before tea was grown at all in many countries. The Tea Research Institute of Ceylon has a large number of field experiments on various types of tea in all tea-growing areas in the Country. Some of these have been in existence for some decades and the oldest statistically-designed experiment has now completed 14 pruning cycles and is in its 42nd year. Long-term trends in fertilizer responses in seedling tea have been carefully studied and deficiency symptoms have been characterized many years ago. The older experiments also provide useful material for developing techniques of leaf and soil analysis. and for checking the validity of the results of these methods. The storehouse of information is abundant, and its systematic collection has been and still is, a major preoccupation of the Institute.

We introduce a new series of articles titled 'The use of fertilizer for tea in Sri Lanka' in this issue of *The Tea Quarterly*. The first article resume in the series by S. Sivasubramaniam, introduces the series and provides a resumé of the history of fertilizer application for Ceylon tea. Future articles in the series will concern the responses to macro and micronutrients and their interactions, as well as critical evaluations of leaf and soil analytical techniques and particularly their applicability for developing a system of providing a rational advisory service for the use of fertilizer in Ceylon tea estates.

Crop losses caused by *Exobasidium vexans*

Blister Blight (*Exobasidium vexans*) has been present in Sri Lanka for a quarter of a century. Ever since the Tea Research Institute of Ceylon provided estates with a method of chemical control of this disease, the estates have meticulously incorporated it into their routine of estate management. Over the years, several refinements in control have been made with a view to reducing expenditure on disease control. In 1965, a programme of work was commenced in order to investigate thoroughly, the question of how much crop is lost as a result of Blister Blight. This programme has how begun to yield its results. In the first article in the new series 'Losses of crop caused by *Exobasidium vexans* Massee on tea', R. L. de Silva, S. Murugiah and T. V. Saravanapavan present the results of their experiments on unshaded seedling tea. These results were originally presented at the 27th Annual Sessions of the Ceylon Association for the Advancement of Science in December 1971.

They find that good control of the disease is essential on fields recovering from pruning and that control is economically worthwhile in the second year of the pruning cycle. In the third and fourth years of the cycle, however, there was no economic advantage in controlling the disease. These are the results of fundamental experiments and before they find wider application on an estate scale confirmatory evidence is necessary. Further, the applicability of these findings to other areas, to different types of tea, under varying environmental conditions still needs elucidation. If the results are eventually found to be similar under more varied conditions, then the industry may look forward to effecting further economies in the control of this disease.

Storage of tea

It is our general experience that manufactured tea undergoes changes on storage, detectable in the consumed product. Some of these changes improve the tea whereas others produce detrimental effects. The chemical basis of these changes has been investigated by R. L. Wickremasinghe and K. P. W. C. Perera, who present the results of their experiments in an article titled 'Chemical changes during storage of black tea'. They report that theaflavins, thearubigins, amino acids, polyphenols and moisture contents of tea underwent quantitative changes during storage. Some of these changes were reflected in market valuations for teas, and these were reduced by some factors and enhanced by others.

Properties of tea polyphenol oxidase

The critical step in black tea manufacture is the fermentation stage for it is here that the desirable aromas and other qualities of teas are developed. Biochemists have been studying this process very intensively and although this process is popularly called fermentation it is basically an oxidation reaction catalysed by certain enzymes

present in the leaf. One of these enzymes, polyphenol oxidase, has been previously isolated and considered to be a homogeneous entity. K. P. W. C. Perera and R. L. Wickremasinghe have separated this enzymic extract by starch gel electrophoresis and have shown that it consists of six different fractions. They have further investigated the effects of addition of various amino acids found in tea, the effect of the variation of pH and the effects of dilution on the development of theaflavins and thearubigins during fermentation. They have identified from these studies the optimal pH for maximum polyphenol oxidase activity and have shown that the period of wither does not affect the activity of this enzyme. However, its activity is considerably reduced by the presence of tannins and this would explain why certain clones which were found to contain high levels of tannin are slow-fermenting clones.

Catechol oxidase in tea plants

Another of the enzymes which takes part in the reaction referred to as fermentation is catechol oxidase. This enzyme has been isolated by G. R. Roberts who shows that this enzyme is not bound to fatty substances in the leaf and that it would be readily insolubilized during the rolling operation. It nevertheless retains its ability to promote oxidations leading to the formation of coloured complexes like theaflavins and thearubigins.

Carbohydrate composition of the polysaccharides of tea

The term carbohydrate is a vague expression used by Chemists to cover a variety of compounds which have basically the same elemental composition, namely one part of carbon to one part of water. However, this term covers materials like glucose, sugar, starches and celluloses. While the former group form the sources of energy for the plant for its diverse activities, the celluloses comprise its structural materials. Thus the plant converts the products of photosynthesis into energy reserves and building material according to its needs. R. R. Selvendran and S. Selvendran have studied the carbohydrate pattern of the stems and the root system of the tea plant. They have looked closely at the cellulosic material, and have shown that the composition of the cellulose fractions which they have separated into hemicellulose and alpha cellulose are quantitatively different. This finding is of considerable significance in that it explains the susceptibility of the tea bush to attack by different types of live-wood termites. As is well known the low-country Live Wood Termite is unable to penetrate below ground level because it would appear that its gastric microflora are unable to digest the celluloses found in the roots. On the other hand the up-country Live Wood Termite is able to attack the roots and work its way up right through the bush. From the findings of the Selvendrans that certain sugars are found predominantly in root wood as opposed to stem wood it would appear that the digestive microflora of the up-country Live-Wood Termite which can process the more indigestible materials of the root could very well handle the relatively more easily digestible materials of the bush, as opposed to their low-country cousins with weaker stomachs. The Selvendrans have also found significant differences in the root bark and stem bark compositions. These differences may also have a bearing on the relative susceptibility of the root and stem to attack by termites and other insect pests.

Biosynthesis and translocation of theanine in the tea plant

Of the many amino acids present in tea, theanine is by far the largest, percentage wise. Its biosynthesis is naturally a problem of great interest. Previously it had been shown that this tea amino acid was not biosynthesized in the leaf. R. L. Wickremasinghe and K. P. W. C. Perera have used the carbon^{14} tracer technique and have shown that although the precursors of theanine are made in the leaf these are translocated to the roots where theanine is manufactured by the plant and again sent back to the developing shoots.

Nutrition and hormones on growth and apical dominance in tea

In this number of '*The Tea Quarterly*' we publish an article titled 'Effects of nutrition and hormones on growth and apical dominance in tea (*Camellia sinensis*)' by S. Kulasegaram and A. Kathiravetpillai. This article is reprinted from the *Journal of Horticultural Science* by courtesy of the authors and editors. It is well known that the tea plant shows a periodicity between active and dormant phases in the growth of its apical buds. This paper reports that the application of a particular level of fertilizer resulted in earlier budbreak, an increase in the number and duration of the active phases with a corresponding decrease in the dormant phases. This resulted in enhanced growth.

These authors also report that gibberellic acid and benzyladenine at certain concentrations tended to bring about earlier budbreak at lower fertilizer levels. These compounds increased plant height. Indole acetic acid increased plant height at lower doses of fertilizer, indicating an interaction between hormones and fertilizer. An interesting relationship between the growth of the shoots, both natural and induced, and that of the roots is reported.