

FIELD AND GLASSHOUSE EXPERIMENTS

A SYMPOSIUM on the "Layout, Management and Recording of Experiments in Field and Glasshouse" was held in London on November 24, 1965, by the Horticultural Education Association, in association with the Association of Applied Biologists and the British Ecological Society. In opening the symposium, Prof. L. Broadbent, president of the Horticultural Education Association, said that members had requested an opportunity to learn something about the principles underlying experimental work without becoming too involved in statistics.

The first paper was by Dr. S. C. Pearce (East Malling Research Station), who discussed "Determining the Objects of the Experiment" so that data could be analysed and results interpreted. Before starting an experiment its objective should be clearly defined and a different hypothesis, suggested by examination of the data, should not be tested although the arithmetic involved might be virtually the same. Variability within even apparently uniform material existed and, indeed, was the basis of the 'analysis of variance'. In good designs, which were based on randomization and replication, variability from external causes, such as soil and environment, could be calculated and removed from the total variation and the likelihood of incorrect results in an experiment could be determined. Although the 'coefficient of variability' was often useful in comparing one experiment with another in a series of experiments, it could be most misleading when used in isolation, as its numerical value depended to some extent on the inherent variability of the material used in the experiment.

D. Cooke (University of Sussex), in considering "The Design of the Experiment", said that a critical examination ought to be made after data had been analysed. This should reveal whether the design selected had been 'efficient', that is, whether the experiment had been worth doing at all and what inferences could be made. He suggested that perhaps it was a pity that there were no critics in science comparable to art critics. He explained why the appropriate unit to use with many experiments involving glasshouse crops is a whole glasshouse and not part of one. It should be recorded in this connexion that nine similar glasshouses have been built at the Glasshouse Crops Research Institute in order that multi-factorial experimental designs may be used.

He also suggested that the effect of 'scaling up' in horticulture should be investigated. Experience had shown that marked effects in experiments were often very much reduced when applied on a large scale, but in the horticultural industry, unlike chemical engineering, no scale models were available.

In discussing the 'three R's' of experimentation—restriction, randomization and replication—Cooke recommended that the major sources of variation often warranted a careful examination. If the residual variation per plot, after allowing for variation due to treatment and block, was large, a different design for future experiments should then be considered to see whether a greater amount of variation could be accounted for and so removed in the analysis of variance.

D. Price Jones (Imperial Chemical Industries, Ltd.), opening the discussion on the foregoing two contributions, commented that pilot trials, general surveys and small simple experiments which could be repeated over a wide range of soils still played an important part. Judging by the many and varied questions which followed, there

is a real desire for guidance from statisticians on such technical matters as the number of plots to use, how to score when qualitative effects are being assessed, how precise measurements should be, and on many other day-to-day matters which have to be decided by experimentalists, even if a statistician is available for overall planning.

"Multivariate Analysis", the subject of J. N. R. Jeffers (Forest Research Station), was introduced by the chairman, Prof. A. H. Bunting (University of Reading), as a logical basis for understanding biological situations. Now that data are processed by electronic computers, lengthy arithmetical calculations may quickly be done, but the real advantage, as Jeffers said, is not in the speed of working but in being able to use techniques hitherto not even contemplated because of their complexity. In the past, when a number of different variates have been measured in an experiment (for example, dry weights, lengths, number of leaves), analyses have been carried out for individual variates, or two of them have first been combined in some way (for example, as a proportion or percentage). In multivariate analysis, however, even when variates are measured in different units (grams, centimetres, etc.), provided they are independent (that is, there is not a constant relation between two of them), a mathematical relationship which includes all the variates may be found to describe a biological situation and comparisons may then be made between different situations. Such a mathematical equation does not immediately show the relative importance which may be attributed to the different variates, but Jeffers outlined how this problem could be solved by a calculation known as principal component analysis. In this analysis data are transformed at the outset to counteract the effect of different units being used and to ensure that one factor is not overweighted because of the arbitrary selection of the original dimensions (for example, measuring in millimetres rather than in centimetres). Two of the transformations in use involve finding a variance-covariance matrix between every set of variates and the computation of a correlation matrix. Jeffers concluded by referring to canonical analysis, another technique which may be used when comparisons are made of biological material and data for a number of variates exist. He forecast that fewer experiments would probably be done in the future, but that they would be larger and better planned and would require the advice of a statistician at all stages, particularly in the interpretation of the results.

It was stimulating to hear of the possibilities of obtaining so much information from one experiment, provided a statistician was at hand to clarify the complex situation which would arise. The ecologist, on the other hand, starts with a complex interacting system containing plant and animal species, different soils and so on, and attempts to describe it mathematically. Dr. M. B. Dale (University of Hull) discussed numerical techniques in ecological research and showed how investigations fall into two main groups, those in which the frequency with which a particular factor is present is recorded and those in which only their presence or absence is noted. In both cases, much depends on the initial decision as to which items to investigate. Samples are taken from appropriate sites, either at random or in some systematic way, rather like taking records at stated intervals of time. The data may be analysed by an 'ordination' technique when the samples are put in sequence, so that the two which differ most are

at the ends. A number of such sequences are possible according to the factors chosen as being most important. A more usual method of handling the data is by 'classification' when like samples are grouped together. In both cases a personal decision as to the relative importance of the different factors involved determines the results; it should be remembered that what seems unimportant at the time of sampling in ecological work may be of great interest in later years. Although both principal component analysis and canonical correlation analysis are being tried, some other analysis, more easily interpreted, is required. Dale is hopeful that, by introducing some form of 'weighting', he will be able to produce a satisfactory classification method.

In the final general discussion, Jeffers said that suitable statistical techniques were becoming so advanced that the service of one professional statistician would be required to about six research workers, if full value was to be obtained from an experiment. With the present shortage of statisticians that ideal seems remote, but members of the symposium welcomed Prof. Bunting's announcement that, beginning in October 1966, there would probably be a one-year M.Sc. course in biometry

at the University of Reading. Nevertheless, research workers will still have to formulate a hypothesis, be able to discuss the layout of the experiment with a statistician, supervise the day-to-day management and obtain appropriate data. Finally, even if the analysis is obtained for him by the statistician, with the use of an electronic computer, he must be able to discuss the interpretation of the results and translate them into biological terms. A working knowledge of the 'language' of statistics and of the underlying principles would seem to be increasingly necessary for all those responsible for field and glasshouse experiments and for those interested in the application of their results. It is hoped that another symposium will be arranged to continue the education of the non-statistician who uses statistical tools.

Members of the three organizations responsible for the symposium are greatly indebted to Mr. J. H. Walker, of East Malling Research Station, for arranging this symposium and to the various speakers for presenting their specialized subjects to an audience of horticulturists and biologists, many of whom had had no formal training in statistical methods.

M. E. MARSTON

EUROPEAN JOURNAL OF CANCER

THERE is, and has been since 1936 when the International Union Against Cancer was founded, extensive international collaboration and exchange in the field of cancer research. This co-operation has been stimulated in recent years by the idea of an international institution of cancer research located in Europe and also by the efforts of the World Health Organization. At the European regional level such groups as the European Committee for Cancer Chemotherapy and the European Committee for Human Tumour Investigation are also playing their part in encouraging inter-European collaboration between clinicians and scientists engaged in the study of cancerous diseases. It is logical that these European groups and their associated workers should now have a journal which will provide a forum for the exchange of ideas and information. This journal is the *European Journal of Cancer* which made its first appearance in June of last year*.

The editorial advisory board of the new journal consists of workers of repute in the cancer field drawn from nine European countries, and the policy of the board will be to publish original work in the field of experimental and clinical cancer research, papers giving the results of planned clinical studies and also general reviews on subjects of particular relevance to these researches and studies.

The first issue contains eight papers from laboratories and centres in Belgium, France, Holland and Italy, so justifying the adjective European in the journal's title. There are two papers from the Radiological Institute of the Netherlands. One by L. M. van Putten presents the results of studies on the effects of different storage techniques on mouse and monkey cell suspensions, and the other is by H. S. Reinhold, in which he describes a combined mechanical and enzymatic method for obtaining a single cell suspension from solid tumour tissue. The method allows a concentrated suspension of a large number of cells to be prepared in a short time. The paper from Milan by G. G. Guidotti and others is on the inhibiting effects of aliphatic aldehydes on protein synthesis in Yoshida ascites hepatoma cells. The paper from France consists of a review by G. Mathé on immunological

reactions in their relationship to the development of cancer and the possibility of immunotherapy in its treatment. The four remaining papers come from Belgium. R. van Nieu and P. J. Thung contribute a paper on the hormonal influence of pregnancy on mouse mammary tumours and its implication for tumour behaviour and progression. J. Hildebrand and C. Coërs report six cases of polyneuritis with severe damage to peripheral nerves in patients receiving intravenous injections of 3-5 mg vincristine per week for varying periods. Vincristine is an alkaloid extracted from the periwinkle flower which, although very toxic, has shown promise as an effective agent in Hodgkin's disease and certain leukaemias, and to a much lesser extent in other tumours. This study confirms previous reports of polyneuropathy caused by vincristine treatment. Another paper dealing with a chemotherapeutic agent is that by Y. Kenis and others, again from Brussels, which reports the results of treating patients suffering from Hodgkin's disease, various lymphomata and leukaemias, with a methylhydrazine derivative. The fourth paper, from a centre in Belgium, consists of a general review of the literature reporting cases of metastatic liver cancer associated with renal dysplasia. This paper is contributed by G. Buyse and others from the hospital at St. Gilles and Brussels University.

The November issue contains the papers given at the International Symposium on the biological characterization of human tumours which was held in May of last year. That these papers should have appeared in print so soon after their formal presentation shows a promptness in symposium publication which is as rare as it is commendable.

The standard of typography and lay-out, the quality of the paper, and the illustrations are of the high standard which we have come to expect from the Pergamon Press. A particularly pleasing aspect is the way in which the bibliographical references are given in full with the titles of the papers quoted. This greatly increases the value of the list of references and is a house rule which could well be copied by other journal publishers. The annual subscription price to individuals is a very reasonable £5 5s. The annual subscription price to libraries is £14, which follows this publisher's usual practice of being at a higher differential rate: a practice which I deplore.

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* *European Journal of Cancer*, 1, No. 1 (June 1965). Pp. 1-74. Published quarterly. Subscription rates: (A) 280s. (40 dollars) per annum for libraries, government establishments and research institutions; (B) 105s. (15 dollars) per annum for individuals who write directly to the publisher and certify that the journal is for their personal use. (Oxford: Pergamon Press, Ltd., 1965.)