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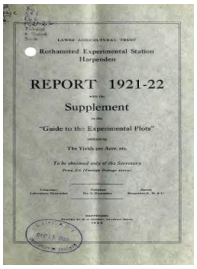
Report 1921-22 With the Supplement to the Guide to the Experimental Plots Containing the Yields per Acre Etc.



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Rothamsted Research

Rothamsted Research (1923) *Statistical Methods and Results : Statistical Department ;* Report 1921-22 With The Supplement To The Guide To The Experimental Plots Containing The Yields Per Acre Etc., pp 33 - 36 **- DOI: https://doi.org/10.23637/ERADOC-1-110**

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However, in the event of any serious deficiency such as an inadequate nitrogen supply, or a prolonged application of ammonium salts only, the influence of the manurial treatment becomes the most important factor and the flora undergoes modification of a similar nature irrespective of the methods of cultivation. In such cases a perennial type of weed, as *Equisetum arvense, Tussilago farfara* or *Cirsium arvense,* was invariably found to predominate.

Comparisons are between with the weeds recorded in 1867 on Broadbalk and Hoos fields and those found at the present day. Considerable reduction in the number of species has taken place in the former case, while changes in the individuals comprising the flora have occurred on both fields.

The distribution and relative abundance of species and individuals are also described in the case of Broadbalk field.

METHODS OF STATISTICAL EXAMINATION AND RESULTS.

STATISTICAL TREATMENT OF SMALL SAMPLES.

VII. R. A. Fisher. *"On the 'Probable Error' of a Coefficient of Correlation deduced from a small Sample."* Metron, 1921. Vol. I., No. 4. pp. 1-32.

Agricultural experiments deal almost invariably with a number of replicated plots, or parallel experiments, which is statistically small; approximate methods suitable for large samples are therefore liable to break down, and to lead to erroneous conclusions. This paper gives the exact form of distribution for correlation coefficients obtained from small samples. By changing the scale upon which the correlation is measured, correlations from small samples may be treated with accuracy, and at the same time corrected for the small bias which is introduced by the standard methods of calculation.

AGREEMENT OF THEORY AND OBSERVATION.

VIII. R. A. Fisher. *"On the Interpretation of χ^2, from Contingency Tables, and the Calculation of P."* Journal of the Royal Statistical Society, 1922. Vol. LXXXV. pp. 87-94.

Statistical tests of the agreement of series of experimental observations with any hypothesis, by which it is intended to interpret them, may be carried out by calculating the statistic χ^2, which measures the discrepancy. The distribution of χ^2, when the hypothesis tested is in fact true, can be calculated, and in this manner cases in which the discrepancy is excessive may be detected. In this paper it is shown that when the data to be tested have been used to construct the hypothetical expectation it is necessary to adopt a more severe test of agreement than that previously in use. This change of procedure, which particularly affects tests of independence in contingency tables, and of the goodness of fit of theoretical curves, may be simply and accurately effected by taking account of the number of degrees of freedom in which observations may differ from expectation, instead of merely the number of frequency classes.

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THEORY OF STATISTICAL REDUCTIONS.

IX. R. A. Fisher. *"On the Mathematical Foundations of Theoretical Statistics."* Philosophical Transactions of the Royal Society, 1922. Vol. CCXXII. pp. 309-368.

The main desideratum in the statistical reduction of data is that the statistics calculated shall include the whole of the information supplied by the data. It has been possible to put this requirement in a mathematical form, and so to lay down general conditions for the complete exhaustion of the data; in particular it is possible to ascertain for any special statistical method proposed, of what percentage of the total information available it makes use. Many such tests are applied to current statistical methods, and in particular to the estimation of the numbers of soil protozoa by the dilution method.

RAINFALL IN BRITAIN.

X. R. A. Fisher and W. A. Mackenzie. *"The Correlation of Weekly Rainfall."* Quarterly Journal of the Royal Meteorological Society, 1922. Vol. XLVIII. pp. 234-242.

To study the effects of weather on crop production by means of simultaneous crop and weather records from different parts of the country, and thereby to reduce the number of years required for the accumulation of data comparable with the existing Rothamsted records, it is necessary to know the correlation between the meteorological records of different stations. Such information is also necessary in repairing defective records from those of neighbouring stations, as also in estimating weather conditions over local areas, such as river basins. This paper is a study of records from Aberdeen, York, and Rothamsted in respect of weekly rainfall. Even Rothamsted and Aberdeen 375 miles apart show a distinct positive correlation (average value .3717) in rainfall; the intermediate station, York, 150 miles from Rothamsted, and 225 miles from Aberdeen, gives average correlations .5898 and .5275. All three comparisons show well marked annual oscillations, the rainfall being most uniform in winter and least so in the early summer. Meteorologists suggest two possible causes for this novel phenomenon: (i.) the summer prevalence of local thunderstorms, (ii.) the more northern track of the summer cyclones. Whatever its cause, it is apparent that simultaneous crop and weather observations will throw light especially on the effects of summer rain or drought.

PREDICTION FORMULÆ.

XI. R. A. Fisher. *"The Goodness of Fit of Regression Formula and the Distribution of Regression Co-efficients."* Journal of the Royal Statistical Society, 1922. Vol. LXXXV. pp. 597-612.

Statistical predictions are based upon regression formulæ, and their importance required that the correction established in Paper No. VIII. (see above) should be applied in detail to such cases. It

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was possible to find the exact distribution of the discrepancy between prediction and observation, and to render previous methods more exact in other points besides that mentioned above. In addition the true form of the distribution of the regression coefficients was established, for which approximate forms only had been previously available.

INHERITANCE CORRELATIONS.

XII. R. A. Fisher. *"On the Dominance Ratio."* Proceedings of the Royal Society of Edinburgh, 1922. Vol. XLII. pp. 321-341.

The effects of selection on the inheritance correlations show themselves in the dominance ratio. The value obtained from human measurements are all close to $\frac{1}{3}$, and this value is not readily intelligible upon the simpler theory in which the effects of selection are ignored. When selection is taken into account it is demonstrated that the dominance ration will rise to $\frac{1}{3}$, thus providing the final step necessary to bring the whole of the existing correlation measurements in mankind into harmony with the Mendelian theory of inheritance.

CROSSOVER RATIOS.

XIII. R. A. Fisher. *"The Systematic Location of Genes by means of Crossover Observations."* American Naturalist, 1922. Vol. LVI. pp. 406-411.

It is shown how the whole of the information supplied by crossover observations may be utilised in determining a consistent system of crossover ratios; the method is based upon that developed in Paper No. IX. (see above), and the working is analogous to that of a solution of least squares.

ACCURACY OF BACTERIAL COUNTING.

XIV. R. A. Fisher, H. G. Thornton, and W. A. Mackenzie. *"The Accuracy of the Plating Method of Estimating the Density of Bacterial Populations."* Annals of Applied Biology, 1922. Vol. IX. pp. 325-359.

As a rule, the accuracy of biometrical determinations must be ascertained empirically from a statistical study of the observations; in certain cases, as has been shown in the theory of hæmocytometer counts, the law of variation may be calculated, and the accuracy known with precision, provided the technique of the counting process is effectively perfect. A study of the extensive bacterial count data accumulated at Rothamsted by Cutler and Thornton, using Thornton's agar medium, indicated that the same law of variation, the Poisson series, was obeyed by the number of colonies counted on parallel plates. Statistical tests were devised which proved that, save for a small proportion of definite exceptions, the necessary perfection of technique was effectively realised. In studying the exceptional cases it appeared that these fall into two classes : (i.) an abnormally high variation which, when investigated experimentally, has been traced to certain bottom spreading organisms isolated from soil from Leeds and from Rothamsted,

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and (ii.) an abnormally low variation ascribable to defective procedure in the preparation of the medium. Application of the same tests to other extensive series of bacterial counts showed that a similar approach to theoretical accuracy, though rare, had been obtained by Breed and Stocking in counts of *B. coli* in milk. It should be emphasised that all cases of departure from the theoretical law of distribution, which have been investigated, are associated with large systematic errors in the counts; for this reason simple tests are presented by which such deviations from the theoretical accuracy of the method can be detected.

ACCURACY OF APHIS COUNTS.

XV. R. A. FISHER. *"Appendix to 'Biological Studies of* APHIS RUMICIS,' *by* J. DAVIDSON." Annals of Applied Biology, 1922. Vol. IX. pp. 142-145.

A special method was developed for determining the accuracy of Dr. Davidson's counts on Aphids; by this means it was possible to show that the 19 varieties of bean tested could be assigned to only six degrees of susceptibility to aphis infestation.

MANURIAL RESPONSE OF POTATO VARIETIES.

XVI. R. A. FISHER and W. A. MACKENZIE. *"The Manurial Response of Potato Varieties."* Journal of Agricultural Science, 1923. Vol. XIII. pp. 311-320.

In an experiment carried out at Rothamsted (1922), twelve potato varieties were each tested with six different manurial treatments, each test being triplicated. Consequently it was possible to test a question upon which very little information has hitherto been available, namely, whether different varieties respond alike to manurial treatment. It is impossible to generalise from a single test of a single species, and it has seemed to the authors of more importance to call attention to (i.) the kind of data required for such an enquiry, and (ii.) the type of statistical treatment needed to elicit an answer, than to emphasise the fact that no significant differences are observable in the manurial response, although the varieties differed much among themselves in yield, and the different treatments also resulted in large differences in yield.

SOIL ORGANISMS.

XVII. E. J. RUSSELL. *"Les Micro-Organismes du Sol dans leurs rapports avec la croissance des plantes. Position actuelle du probléme."* Ann. de la Sci. Agronomique, 1921. pp. 49-67.

A review of the present position of our knowledge on this subject.

ALGÆ.

XVIII. B. MURIEL BRISTOL and HAROLD J. PAGE. *"A Critical Enquiry into the Alleged Fixation of Atmospheric Nitrogen."* Annals of Applied Biology, 1923. Vol. X. pp. 1-30.