THE DETERMINATION OF THE NUMBER OF SAMPLES NECESSARY TO MEASURE DIFFERENCES WITH VARYING DEGREES OF PRECISION

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In 1911, Wood presented a formula to facilitate the calculation of the number of plats or other units required to attain any desired degree of precision of measurement for any experiment. The formula is based on the derivation of the probable error of a mean (PE_m) from the relationship of the probable error of a single determination (PE_s) to the total frequency (n), namely, PE_m = PE_s / √n.

Since much agronomic research is concerned with the significance of the difference between two means and since it is not always possible to predict which of the means will be the greater, Wood's original formula will be modified in order that it may be more generally applicable to any situation.

The probable error of a difference (PE_D) is equal to the square root of the sum of the squared errors of each of the two means, as follows:

\[ PE_D = \sqrt{(PE_A)^2 + (PE_B)^2} \]

It may be assumed that the errors of the two means will not be greatly different each from the other, so the equation may be written

\[ PE_D = \sqrt{2} PE_M. \]

The mathematical significance of the difference (D) is estimated by the magnitude of the ratio of the difference to its probable error, or

\[ \frac{D}{PE_D} \]

Whatever level of significance this ratio must attain is purely arbitrary and may be decided by the individual. However, as a matter of fact, odds of 30:1 are rather commonly accepted as indicative of mathematical significance. The D/PE_D ratio necessary for odds of approximately 30:1 is 3.17. In other words, the difference must be slightly more than three times its probable error.

The general formula to determine the number of units necessary to measure a certain difference with any desired degree of precision is developed as follows: Since PE_D = \sqrt{2} PE_M, then

\[ \frac{D}{PE_D} = \frac{D}{\sqrt{2} PE_M} \]

and since PE_M = PE_s / √n, then

\[ \frac{D}{PE_D} = \frac{D}{\sqrt{2} \cdot PE_s / \sqrt{n}} \]

Paper No. 191, Department of Plant Breeding, Cornell University, Ithaca, N. Y. Received for publication December 10, 1932.

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