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A Note on the Technique of "Ranking" in Plant Breeding

by

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Very often plant breeders face the difficulty of placing various types or cultures in order of merit for one or more of their attributes. Cotton varieties, for example might be ranked for their vigour, squaring or disease resistance into definite groups as better than, equal to or poorer than the standard (the local strain cultivated). New varieties under trial for the first time might be ranked in order of merit without assigning any numerical measure of intrinsic worth to each type. Ranking arises naturally in cases where for lack of time, money or instruments, measurement of a characteristic is considered impossible. It is not possible for a cotton breeder, for example, to count the number of bolls or squares of every type particularly when he deals with large collection of material. He can only rank these types into certain definite groups. We are sometimes forced to have recourse to ranking methods even when measurements have been made, in order to reduce the labour of computation or to get an idea of the general trend.

Spearman's rank correlation coefficient is the best known technique in this field. Suppose we have ten cotton types ranked for red-leaf resistance in order of merit by designating the decreasing grades of resistance as 1 to 10 by two observers. Let us also suppose that when the ten varieties are denoted by the letters A, B, C, ... J and the two observers as X and Y, the following ranking results are obtained.

Varieties	A.	B.	C.	D.	E.	F.	G.	H.	I.	J.
Ranked by observer X	2	1	3	4	6	5	8	7	10	9
Ranked by observer Y	3	2	1	4	6	7	5	9	10	8
Rank difference (Y—X) = d	1	1	−2	0	0	2	−3	2	0	−1
Sq. of difference = d^2	1	1	4	0	0	4	9	4	0	1

The problem is to find whether the two observers show evidence of agreement in regard to ranking. This is solved by Spearman's rank correlation co-efficient which is denoted by

$$R = 1 - \frac{6\,\Sigma d^2}{n^3 - n}$$

Where Σd^2 is the sum of squares of rank differences, and 'n' is the number of types ranked. In the above example Σd^2 is 24 with 'n' equal to 10, so that the correlation co-efficient is

$$R = 1 - \frac{6 \times 24}{1000 - 10} = 0{\cdot}85.$$

The rank-correlation co-efficient has been so designed that the value will be plus 1 when the rankings are indentical and minus 1 when they are at their maximum disagreement. In the case of the example, the observers X and Y show a fair agreement between each other in their ranking of the varieties for their resistance to red leaf disease. But there is every possibility that the measure of agreement may have arisen by chance. In order to test it, we have to work out the significance of rank correlation co-efficient. If 'n', (the number of items ranked) is not less than 10, we may calculate Students 't' as $R\sqrt{\frac{n-2}{1-R^2}}$ with n—2 degrees of freedom. Making the necessary substitution in the formula we find

$$\text{Students} \quad t = 0{\cdot}85 \sqrt{\frac{10-2}{1-85^2}} = 4{\cdot}55.$$

The value of 't' from table ($P = 0{\cdot}01\%$) with 8 degrees of freedom is 3·355. As our value is higher than this, we conclude that the degree of agreement between the two observers is significant.

There is every possibility here that both the observers may be wrong in their rankings even though they may both agree. To test whether an individual is a good judge, we can use the same Spearman's rank correlation co-efficient. Suppose there are ten types of cotton, the number of squares produced by them are actually counted, the types are ranked by observer, the capacity of the observer is to be judged and the ranking recorded by him is as follows :

	A.	B.	C.	D.	E.	F.	G.	H.	I.	J.
True rank by actual counting	1	2	3	4	5	6	7	8	9	10
Rank given by the observer	3	2	4	1	7	5	10	6	9	8
d =	2	0	1	−3	2	−1	3	−2	0	−2
d^2 =	4	0	1	9	4	1	9	4	0	4

which gives $\Sigma d^2 = 36$ with $n = 10$

$$R = 1 - \frac{6\ \Sigma d^2}{n^3 - n} = 1 - \frac{216}{990} = 0{\cdot}78$$

from which we can calculate.

$$\text{Students 't'} = R\sqrt{\frac{n-2}{1-R^2}} = 0{\cdot}78\sqrt{\frac{10-2}{1-0{\cdot}78^2}} = 3{\cdot}5.$$

The 1% level of Students 't' with n—2=8 degrees of freedom is 3·36. We therefore conclude that the observer's ranking correlates significantly with the true ranking.

Spearman's rank correlation co-efficient is thus a very useful technique in finding out (a) whether two independent observers show significant agreement between them in ranking a set of types and (b) whether an experimentalist is proficient enough to judge the various types by ranking them without any actual measurement.

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Some Studies of 2, 4-D Toxicity in Soils in Herbicidal Concentrations

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It has been pointed out by many investigators in several instances that 2, 4-Dichlorophenoxy acetic acid, applied in herbicidal concentrations leaves toxic effects in the soils. Attempts have been made by workers to assess the persistence of its toxicity and in almost all these studies the emergence of certain seedling like tomato, cucumber and beans have been used as criteria. Nutman et al (1945) reported that 2, 4-D when applied in small quantities of herebicidal concentrations had some toxic effect on soil but it disappeared in a course of 36 days. Mitchell and Marth (1948) found soils kept in dry conditions were toxic even at the end of 18 months. De Rose (1946) Taylor (1947) and Kries (1947) all noted that 2, 4-D persists in soils and supresses germination and growth of plants. Brown and