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PROBLEMS OF EARLY DECISION-MAKING IN DUS TESTING

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1. INTRODUCTION

There is increasing pressure on authorities to reach rapid decisions on applications for variety registration. In practice, for most species, a decision is made on the basis of results from two test sowings, with the possibility of a third test in some circumstances. However, in many countries a variety will be approved after the first sowing if it is obviously distinct. Is it possible to objectively define what is "obvious" with a measured characters? This note explores some of the statistical issues concerned with distinctness and uniformity testing when there is a wish to make a decision after only one sowing.

2. BACKGROUND

As set out in the UPOV guidelines for the conduct of DUS tests, two varieties can be considered to be distinct if the difference between the varieties

- has been determined in a least one testing place,
- is clear and
- is consistent.

In the case of measured characters a clear and consistent difference is determined by:

- carrying out the tests with the two varieties;
- calculating the average difference between the varieties and, also, the variation in the difference (the variance);
- using the variance to estimate a difference [a least significant difference (LSD) or minimum difference] that is large enough only to occur infrequently when there is no real difference between varieties;
- if the average difference from the tests is greater than the LSD then the varieties may be declared to be distinct.

In practice, the tests involve more than two varieties and the variance is based on variation in differences between all pairs of varieties. There are several important points to remember when working with this variance:

- the variance should incorporate all of the main sources of variation involved in the tests including between-test variation, since judgements about distinctness should, ideally, be reproducible in subsequent tests;
- the data should come from varieties that are of a similar type, e.g. maturity;
- allowance should be made for differences between tests in the range of expression of a character, e.g. by means of modified joint regression analysis;
- occasionally data do not satisfy some of the assumptions which underpin the application of LSDs; e.g. a log transformation of the data may be necessary to deal with circumstances in which the variance changes in line with the expression of the character;
- a check should be made that the variation in differences between any two varieties is not out-of-line with the average variation amongst all pairs of varieties.

3. DECISIONS FROM A SINGLE SOWING

Two issues must be addressed if an objective criterion for distinctness is to be based on results from one sowing:

- LSDs must be calculated from long-term experience with the variability of the tests;
- when establishing a distinctness standard one would like to be confident that a distinctness decision will not change if information comes available from later sowings.

A possible strategy to address these issues has been described in UPOV paper TWC/13/7 titled "Analysis of Single-year Results Using Long-Term LSDs for Herbage Species" and written by S.T.C. Weatherup.

In paper TWC/13/7 the LSDs appropriate to a single sowing are based on the residual variance from a fitting constants analysis of data from the current sowing and earlier sowings of similar trials.

To provide robustness against the greater variability that may occur in some sowings, the probability level for the LSD is adjusted. For example, an LSD of 1% after two sowings is replaced by an LSD of 0.1% for a single sowing.

An illustration of how this might operate is shown in Table 1 with data from pea DUS trials. The Long-Term LSDs are based on a fitting constants analysis of data on 617 varieties sown in DUS trials at the Scottish Agricultural Science Agency's trial grounds over the six-year period 1988-93. Columns 2-4 of Table 1 give the combined-over-years LSDs (prob=1%) for comparing variety means after 3, 2 and 1 sowing year respectively. The final column has the LSDs at the 0.1% level. Clearly, such differences are large and it may only be the occasional case that allows a decision after a single sowing. Nevertheless, it is important to set high standards to ensure that a large difference in one year cannot be reduced to non-significance after a further year.

Table 1 : Pea DUS trials - SASA Edinburgh 1988-93 - Long term COY LSDs

Character	**3 year LSD**	**2 year LSD**	**1 year LSD**	**1 year LSD**
	Prob=1%			**Prob=0.1%**
Plant ht at 80% flowering (cms)	10	12	18	23
Petiole length(mm)	10	12	17	22
Peduncle length (mm)	15	18	26	33
Days to first flowering	2	3	4	5
Days to 80% flowering	2	3	4	6

4. DECISIONS FROM SOWINGS AT TWO CENTRES

An alternative approach to achieving early decisions might be to use data from tests that have been conducted at two centres simultaneously. Information from the two centres would be combined in a number of ways.

a) Averaging over centres

One method might be to average variety means over the two centres and compare the average differences between varieties against a LSD based on the variety-by-centre interaction. However, the current UPOV position is that " *two varieties have to be considered distinct if the difference has been determined in at least one testing place* ". This suggests that combining the data from two centres would not satisfy this condition.

There are other disadvantages with averaging over centres:

- it is not easy to clearly define how diverse centres must be in order to represent separate environments; obviously adjacent fields are not satisfactory but are neighbouring districts or neighbouring regions appropriate ? One way of assessing this is to compare the COYD LSDs for pairs of years with the combined-over-centres LSD for pairs of centres within a year; if the latter is much less than the COYD LSD, for the main DUS characters, then the centres are too similar to be treated as separate environments.
- averages over centres can dilute variety differences which exist in one centre but are weak or absent in the other centre; so we need some way of utilising information on variety differences that are clear in one centre but not another;

b) Distinctness at either centre

A more satisfactory approach would seem to be to make the decision separately for each centre, perhaps using COYD at each centre. LSDs would be calculated as described in 3. above. A variety may then be judged to meet requirements if it satisfies COYD standards at either centre.

An advantage of this approach is that it makes use of variety differences that are apparent at either centre. However, it may be argued that it is unlikely that a variety could be considered to have a "clear and consistent" difference if it was not distinct at both centres, i.e. if the difference does not repeat over centres it is less likely to repeat over years.

5. DISCUSSION

a) Uniformity

Consideration must be given as to how uniformity is to be assessed from one sowing. In order to achieve a uniformity standard that is similar to that of a multi-sown test the probability level applied in the combined-over-years-uniformity (COYU) criterion might be adjusted. The principle of adjusting the COYU probability to allow decisions after 2 or 3 years has already been established.

In the case of two-centre testing it seems logical to seek uniformity at the centre where distinctness is established.

b) Recommendations for action

If decisions on the basis of a single sowing are to be allowed within UPOV then three steps seem to be essential:

- estimates of long-term LSDs should be obtained and assessed for robustness against the 2- and 3-sowings LSDs for the same data;
- appropriate probabilities for single sowing LSDs have to be established at a level which limits the risk that a decision might subsequently be changed;
- the probability levels to be used with the COYU criterion should be agreed.

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