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STUDY ON THE USE OF DATA FROM MULTIPLE LOCATIONS IN DUS TESTING

Document prepared by experts from Germany

Introduction:

1. DUS trials are usually carried out at one testing location. In field crops, decisions about distinctness, uniformity and stability are taken after two or three growing cycles. Depending on specific demands of certain species and on specific environmental conditions some authorities perform DUS tests for a crop at two locations. General guidance on the use of information from multiple locations is provided in TGP/9. The present study analyses different options for combining data from two locations.

2. The study was based on data for winter oilseed rape. DUS tests for winter oilseed rape are performed in Germany at two locations. The same varieties are grown and all characteristics are observed at both locations. For the assessment of DUS, both locations are considered independently. A variety is considered to be DUS if in at least one location all criteria are fulfilled. One reason for the second location is for security. In addition, the second location is important in order to allow for location effects on the expression of characteristics and consequently to ease the establishment of distinctness for the large number of candidate varieties.

3. The aim of this study was to identify the most informative way to analyse the data in relation to the assessment of DUS under consideration of probability levels. Data analysis was carried out for all characteristics which are observed by measurements of individual plants and for which COYU and COYD are applied.

Method:

4. In the case of two locations, there are different possibilities to evaluate statistically the data:

Option 1: Individual consideration of each location
Assessment of distinctness and uniformity on data of each of the locations separately by calculation of LSD-values at 1% level (COY-D probability level)
Model effects: variety, year, error for each location

Option 2: Combined calculations (years and locations)
Assessment of distinctness and uniformity on a combination of data of both locations (average per variety) by calculation of LSD-values at 1% level (COY-D probability level). Years and locations are separate effects in the model.
Model effects: variety, location, year, variety x location, variety x year, error

Option 3: Combined calculations (environments)
Assessment of distinctness and uniformity on a combination of data of both locations (average per variety) by calculation of LSD-values at 1% level (COY-D probability level). Years and locations are levels of the same effect (environments) in the model.
Model effects: variety, environments, error

Option 4: Combined calculations on a single location level
Assessment of distinctness and uniformity on a combination of data of both locations (average per variety and location) by calculation of LSD-values at 1% level (COY-D probability level). Years and locations are separate effects in the model as in option 2.

LSD-vales were calculated on level of one location by using of the same error as in option 2.
Model effects: variety, location, year, variety x location, variety x year, error

Option 5: conduction and evaluation of a single DUS test at one location
Assessment of distinctness and uniformity on data of the single location by calculation of LSD-values at 5% level (COY-D probability level).
Model effects: variety, year, error for the single location

5. All calculations were based on variance components estimated for quantitative characteristics which are measured on individual plants. Data of four three-year-cycles (1997-2002) of two testing stations (Scharnhorst and Eder) were included in the evaluation. Table 1 shows the examined characteristic and its number in the UPOV Test Guidelines TG/36/6.

Table 1: Examined characteristics

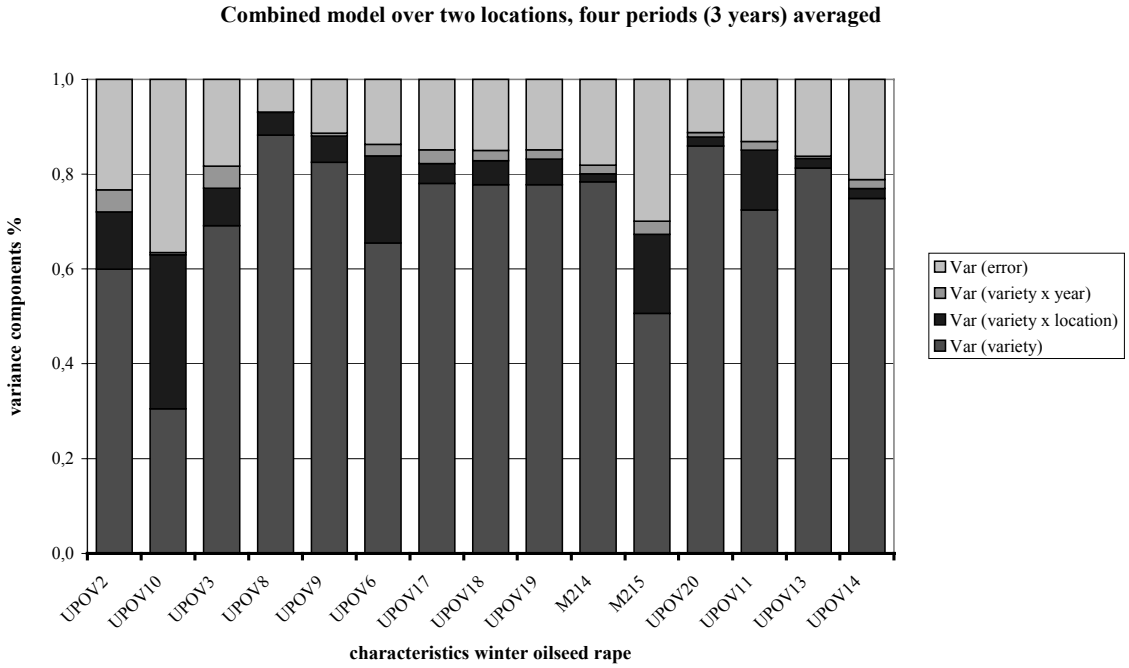
Characteristic	UPOV no.
Cotyledon: Length	2
Cotyledon: Width	3
Leaf: Number of lobes	6
Leaf: Length of petiole	10
Time of flowering	11
Flower: Length of petals	13
Flower: Width of petals	14
Plant: Total length including side branches	17
Siliquia: Length	18
Siliquia: Length of beak	19
Siliquia: Length of peduncle	20

6. In addition, simulation studies based on the variance components have been carried out to estimate power function and the type II error. Potential differences between varieties were modified for simulation studies and LSD-values were computed. For each characteristic, the proportion of distinct variety pairs was calculated.

Results:

7. Variance components of the 15 analysed characteristics of oilseed rape are shown in Figure 1. It is obvious that the genotypic variance has the greatest influence on the variation of nearly all characteristics. The variance components confirm that the chosen characteristics are appropriate for DUS assessment. Interactions between variety and location are greater than variety x year interactions for all characteristics.

Figure 1: Variance components of rapeseed (1997-2002) on basis of two locations



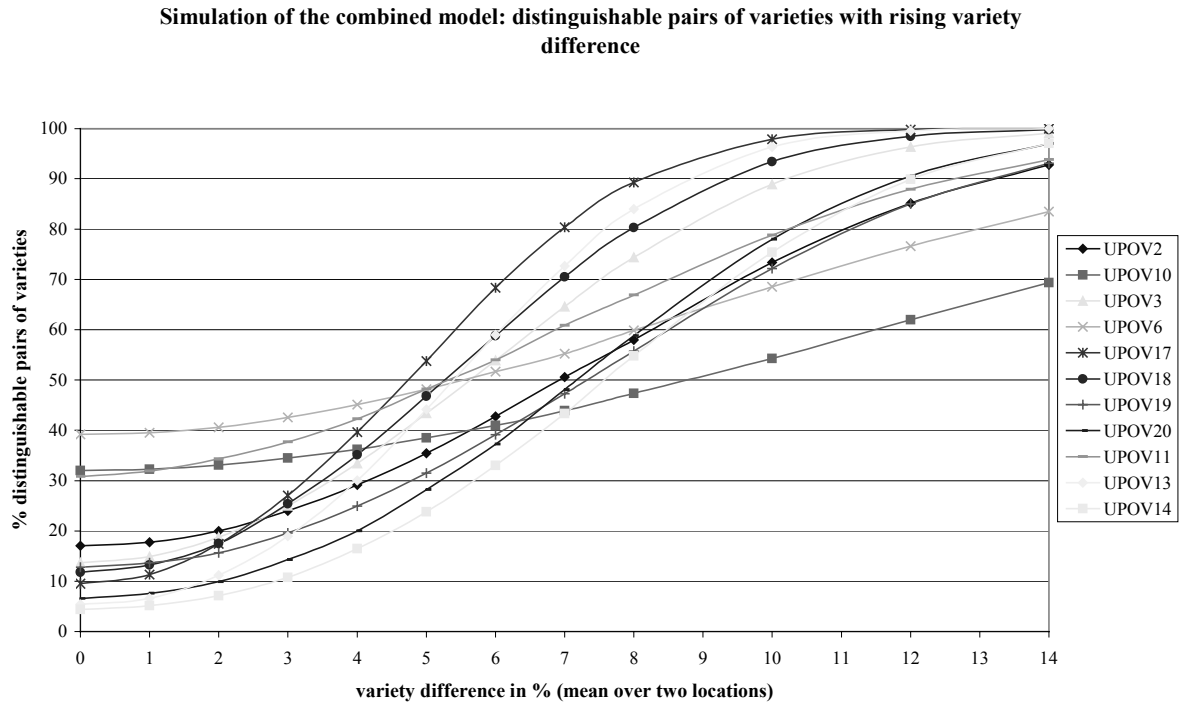
Option 1 (Individual consideration of each location):

Simulation studies validated the influence of interaction between varieties and locations on distinctness decisions. With increasing variety x location interaction of a specific characteristic, the probability increases to consider two varieties to be clearly different on the basis of one location even if the difference between the variety means over both locations is small.

If varieties are compared location by location on a 1% level, and one location is finally chosen for decision, it could be shown by simulation studies with variance components from the combined analyses that the minimum probability level in relation to the difference between variety means over locations increases to 2%.

The simulation study shows that the number of distinct varieties increases with the size of difference between the varieties. For characteristics with high variety x location interaction up to 40 percent of pairs of varieties have been considered to be distinct on the basis of one location, although there was no significant difference between the variety means over locations (see Fig. 2, char. 6).

Figure 2: Power functions of different winter oilseed rape characteristics



Option 2 (Combined calculations (years and locations)):

Results vary from case to case:

(a) It is possible that small differences increase in the combined analyses (same direction of the difference in both locations) to significant differences, which is rarely found. In most of the cases there is no intensification.

(b) A variety pair is distinct in a location but non distinct using combined calculation including years and locations.

(c) Two varieties are distinct in both of the two locations but the difference is not in the same direction. Thus, the combined calculation leads to non distinctness.

Option 2 was calculated for 5 characteristics on a 1%- and a 5%-level for the combined calculations.

1%-level results:

In the testing cycle 1997 to 1999, 14 candidate varieties were distinct with option 1 but only 6 candidate varieties were distinct with option 2. In 1998 to 2000, 20 were distinct with option 1 and 12 with option 2. In 1999-2001, 24 were distinct with option 1 but no candidate variety was distinct with option 2.

5%-level results:

In the testing cycle 1997 to 1999, 14 candidate varieties were distinct with option 1 but only 10 candidate varieties were distinct with option 2. In 1998 to 2000, 20

were distinct with option 1 and 16 with option 2. In 1999-2001, 24 were distinct with option 1 but no candidate variety was distinct with option 2.

Option 3 (Combined calculations (environments)):

Results are nearly the same as for option 2. Years and locations treated as equal. This option was calculated for all 11 characteristics. 64 candidate varieties have been considered to be distinct using option 1 and 56 candidate varieties were distinct with option 3 (1999-2001). Results of other test cycles are missing simply because there was not enough time for all calculations.

This model is in contradiction to the results from estimation of variance components where interactions between variety and location are greater than variety x year interactions for all characteristics. Thus, further consideration of option 3 is not useful for this winter oilseed rape example.

Option 4 (Combined calculations on a single location level):

In option 4 data of both locations are used to get an unique error (for each location the same error). Data of only one location are the basis to compute the mean of the variety. This option was calculated for 5 characteristics. In the testing cycle 1999 to 2001, 24 candidate varieties were distinct with option 1 but no candidate variety was distinct with option 4. The reason is that the mean error is not optimal either for the first location or for the second.

Option 5 (conduction and evaluation of a single DUS test at one location):

Assessing DUS on each location separately by increasing probability level to 5% leads to the same results as option 1. This option was calculated for all 11 characteristics.
Results of location Scharnhorst:
64 candidate varieties could be distinguished using option 1 and 63 candidate varieties were distinct with option 5 (Years: 1999-2001).
Results of location Eder:
64 candidate varieties could be distinguished with option 1 and 9 candidate varieties were distinct with option 5 (Years: 1999-2001).
Results of other test cycles are missing simply because there was not enough time for all calculations.

8. In Table 2, all results of option 1 to 5 are summarised.

Table 2: Summary of results for options 1 to 5

option					2		3	4	5	
	probability level				1%	5%	1%	1%	5%	5%
	location				E,S	E,S	E,S	E,S	E	S
	number of char.	years	location	number of distinct candidates						
1	5	1997-1999	E,S	14	6	10	-	-	-	-
1	5	1998-2000	E,S	20	12	16	-	-	-	-
1	5	1999-2001	E,S	24	0	0	-	0	-	-
1	11	1999-2001	E,S	64	-	-	56	-	63	9
	E: Location Eder S: Location Scharnhorst									

Conclusions:

9. Due to significant variety x location effects, the combination of data from different locations may be a disadvantage for the establishment of distinctness. In several pair-wise comparisons, clear differences could be observed at one location but there was no clear difference between the variety means over locations (Option 1 vs. Option 2, 3 and 4). For the presented data in winter oilseed rape it is therefore not recommended to use combined analyses.

10. In the German system, the second location acts on the one hand for insurance to achieve results of good quality independent of difficult weather conditions or other risks. On the other hand, the high number of candidate varieties to be compared with a large reference collection requires a very efficient and reliable testing system to establish distinctness. The use of location effects and variety x location interaction is a very efficient element in that respect.

11. In order to distinguish the same number of varieties at one location as it is currently achieved with two locations would require a decrease of the probability level for the remaining location (Option 5). A decrease to at least 5% would be necessary but this can vary with location and characteristic.

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