

**TWC/23/15****ORIGINAL:** English**DATE:** June 6, 2005

INTERNATIONAL UNION FOR THE PROTECTION OF NEW VARIETIES OF PLANTS
GENEVA

**TECHNICAL WORKING PARTY
ON
AUTOMATION AND COMPUTER PROGRAMS**

**Twenty-Third Session
Ottawa, June 13 to 16, 2005**

**INFLUENCE OF THE NUMBER OF PLANTS PER PLOT ON UNIFORMITY AND
DISTINCTNESS FOR QUANTITATIVE CHARACTERISTICS IN RAPESEED**

Document prepared by experts from Germany

INFLUENCE OF NUMBER OF PLANTS PER PLOT ON UNIFORMITY AND DISTINCTNESS FOR QUANTITATIVE CHARACTERISTICS IN RAPESEED

Introduction

1. The purpose of the document is to demonstrate the influence of the number of plants per plot on uniformity and distinctness. The number of plants is fixed in the Test Guidelines for the species and is the same for each characteristic. A standard situation in DUS testing is to use 60 plants (3 times 20 plants) for assessment of distinctness and uniformity. For some species the workload for the assessment of all quantitative characteristics on 60 plants is very high and crop experts are looking for possibilities to reduce this workload.

Trial data

2. All computations were made with DUS data from Germany for the years 2002 to 2004 on rapeseed. The two locations were 'Scharnhorst' and 'Nossen'. The numbers of reference and candidate varieties are given in Table 1.

Table 1: Locations, years and number of varieties

Location	Year	Number of reference varieties	Number of candidate varieties (3 years)	Number of candidate varieties (2 years)	Total number of varieties
Scharnhorst	2002, 2003, 2004	301	57	100	458
Nossen	2003, 2004*	286	-	154	440

*) data of year 2002 are missing in Nossen because of changing a trial station

3. The most important quantitative characteristics, their code and the type of assessment are shown in Table 2.

Table 2: Characteristics, codes and type of assessment

Characteristic	Code	Assessment
Cotyledon: length	M11	Image analysis
Cotyledon: width	M12	Image analysis
Leaf: length	M14	Measurement
Leaf: width	M15	Measurement
Leaf: number of lobes	M19	Count
Leaf: length of petiole	M110	Measurement
Plant: total length including side branches	M21	Measurement
Siliqua: length	M212	Measurement
Siliqua: length of beak	M213	Measurement
Siliqua: width	M214	Measurement
Siliqua: length of peduncle	M216	Measurement
Time of flowering	M31	Count

Methods

4. To reduce the number of plants per plot sub-samples of 60 plants were formed in different ways. Table 3 shows the different cases which depend on number of plants per plot and number of replications used.

Table 3: Different sub-samples of 60 plants depending on number of plants per plot and number of replications

Case	Number of plants per variety	Number of replication x number of single plants	Comment
A	60	3 x 20	Standard
B	45	3 x 15	First 15 plants
C	40	2 x 20	Replication 1 and 2
D	40	2 x 20	Replication 1 and 3
E	30	3 x 10	First 10 plants
F	30	3 x 10	Second 10 plants

5. To estimate the influence on assessment of uniformity, COY-U criterion for all cases (case B to F) were calculated and compared by the standard calculation (case A).

6. In addition, the influence on results of distinctness calculations (COY-D) were examined. These calculations were done by using data of reference varieties of trial station 'Scharnhorst' only. LSD values were calculated for each case and all varieties were compared with each other.

Results

(a) Uniformity decisions

7. In Table 4 different results of uniformity assessments for case A and each of the other cases for each characteristic are shown (Comparison of results of case A and case B, of case A and case C and so on).

8. The maximum number of different decisions between the standard case and the case with a reduced number of plants is 4.9%, for characteristic M212 'Siliqua: length'. All Siliqua characteristics and the characteristic 'Time of flowering' have an increased percentage of different results.

9. The two year results of the trial station 'Nossen' also have an increased percentage of different results in comparison to the 3 year results of the trial station 'Scharnhorst'.

10. There is no tendency to an increasing percentage of different results by decreasing number of plants per plot if percentage of number of reference varieties is used as criterion.

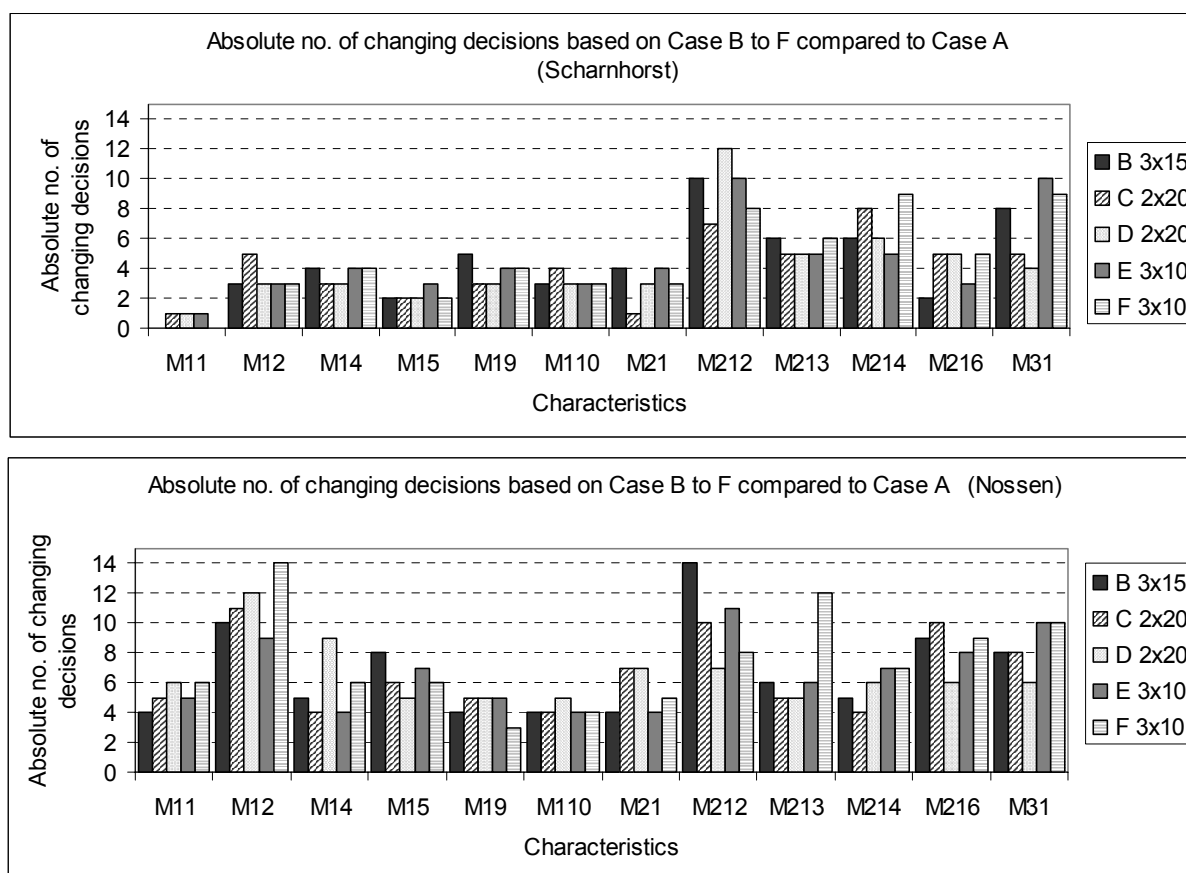
Table 4: Different uniformity results for each characteristic (percentage of number of reference varieties) for cases as described in Table 3

	Scharnhorst* (3-year results)					Nossen* (2-year results)				
	%					%				
	Case B 3x15	Case C 2x20	Case D 2x20	Case E 3x10	Case F 3x10	Case B 3x15	Case C 2x20	Case D 2x20	Case E 3x10	Case F 3x10
M11	0.0	0.3	0.3	0.3	0.0	1.4	1.8	2.1	1.8	2.1
M12	1.0	1.7	1.0	1.0	1.0	3.5	3.9	4.2	3.2	4.9
M14	1.3	1.0	1.0	1.3	1.3	1.8	1.4	3.2	1.4	2.1
M15	0.7	0.7	0.7	1.0	0.7	2.8	2.1	1.8	2.5	2.1
M19	1.7	1.0	1.0	1.3	1.3	1.4	1.8	1.8	1.8	1.1
M11 0	1.0	1.3	1.0	1.0	1.0	1.4	1.4	1.8	1.4	1.4
M21	1.3	0.3	1.0	1.3	1.0	1.4	2.5	2.5	1.4	1.8
M21 2	3.3	2.3	4.0	3.3	2.7	4.9	3.5	2.5	3.9	2.8
M21 3	2.0	1.7	1.7	1.7	2.0	2.1	1.8	1.8	2.1	4.2
M21 4	2.0	2.7	2.0	1.7	3.0	1.8	1.4	2.1	2.5	2.5
M21 6	0.7	1.7	1.7	1.0	1.7	3.2	3.5	2.1	2.8	3.2
M31	2.7	1.7	1.3	3.3	3.0	2.8	2.8	2.1	3.5	3.5

*Number of reference varieties: Scharnhorst= 301; Nossen= 286

11. In Figure 1 Absolute values of decisions were shown.

Figure 1: Absolute uniformity results of cases B to F with reduced number of plants (reference varieties only) for trial stations ‘Scharnhorst’ and ‘Nossen’



12. At location ‘Scharnhorst’, further differentiation of results which differ by direction of changes (uniform to non-uniform and reverse) shows the tendency to increasing of uniformity decisions by reduced number of plants (Table 5). This tendency is weaker for 2-years results at location ‘Nossen’.

13. In Table 5 the actual situation (case A) is compared to a sub-sample (case B to F). The sign ‘-/+’ means that case A is compared to case B, for example, and the decision changes from not uniform to uniform. The sign ‘+/-’ means that case A is compared to case B, for example, and the decision changes in the other direction from uniform to not uniform.

Table 5: Differentiation of uniformity results which differ by direction of changes

	Case B 3x15		Case C 2x20		Case D 2x20		Case E 3x10		Case F 3x10	
	-/+*	+/-	-/+	+/-	-/+	+/-	-/+	+/-	-/+	+/-
Scharnhorst (301 reference varieties, 3-year results)										
M11				1		1		1		
M12	3		3	2	3		3		3	
M14	3	1	3		3		3	1	3	1
M15	2		2		2		2	1	2	
M19	3	2	2	1	2	1	3	1	1	3
M110	3		3	1	3		3		3	
M21	3	1	1		3		3	1	3	
M212	7	3	3	4	7	5	6	4	6	2
M213	4	2	3	2	4	1	4	1	3	3
M214	4	2	4	4	3	3	4	1	3	6
M216	2		4	1	5		3		4	1
M31	5	3	5		3	1	5	5	6	3
Nossen (286 reference varieties, 2-year results)										
M11	4		5		5	1	4	1	5	1
M12	7	3	6	5	7	5	6	3	7	7
M14	3	2	2	2	3	6	3	1	3	3
M15	4	4	3	3	2	3	3	4	2	3
M19	2	2	2	3	2	3	2	3	2	1
M110	4		4		4	1	4		4	
M21	3	1	2	5	2	5	3	1	2	3
M212	6	8	5	5	3	4	7	4	4	4
M213	4	2	3	2	3	2	4	2	9	3
M214	5		2	2	5	1				3
M216	4	5	5	5	5	1	7	1	5	4
M31	4	4	4	4	3	3	5	5	6	4

*(standard sample / sub-sample; + => uniform, - => non uniform

14. A limit of allowed changes could be 1% for 3-year results as sum of two possibilities (-/+ and +/-) per comparison of different cases. This is an assumption. So for M212, M213, M214 and M31 (Siliqua characteristics and Time of flowering) reduction of the number of plants would not be acceptable at location 'Scharnhorst'.

15. There is no best case of reduction for this example.

(b) Effects on distinctness decisions

16. The effect on distinctness decisions is described below.

17. In Table 6 the actual situation (case A) is compared to a sub-sample (case B, C and E). The sign ‘-/+’ means that case A is compared to case B, for example, and the decision changes from not distinct to distinct. The sign ‘+/-’ means that case A is compared to case B, for example, and the decision changes in the other direction from distinct to not distinct.

18. At location ‘Scharnhorst’, further differentiation of results which differ by direction of changes (distinct to not distinct and reverse) shows the tendency to decreasing of the number of distinct variety pairs from reduced number of plants and reduced number of replications (Table 6).

Table 6: Distinctness results which differ by direction of changes for each characteristic (percentage of total number of variety pairs)

	Scharnhorst (3-year results)*					
	Case B		Case C		Case E	
	3x15		2x20		3x10	
	+/-**	-/+	+/-	-/+	+/-	-/+
M11	5.1	1.4	9.7	0.9	6.5	1.8
M12	5.7	1.2	7.4	1.2	7.7	1.4
M14	1.5	0.7	4.4	1.9	2.3	1.3
M15	2.3	1.2	7.0	1.9	4.5	1.8
M19	2.4	1.1	5.1	1.5	4.9	1.6
M110	1.3	0.9	4.2	1.8	2.2	1.4
M21	1.4	0.9	4.2	1.2	3.0	1.3
M212	2.1	1.3	3.8	1.4	4.3	1.5
M213	2.3	1.2	8.3	0.9	4.6	1.5
M214	2.3	1.1	7.6	1.1	4.3	1.4
M216	1.3	1.0	5.0	2.0	2.7	1.2
M31	2.2	1.8	2.3	2.1	3.5	2.7

* 301 reference varieties => 45150 pair-wise comparisons

** (standard sample / sub-sample; + => distinct, - => not distinct)

19. A limit of allowed changes could be 5% as the sum of two possibilities (-/+ and +/-) per comparison of different cases. This is an assumption. So for M11 ‘Cotyledon: length’ and M12 ‘Cotyledon: width’ a reduction of the number of plants would not be acceptable. Case C is the worst case for all characteristics except M31 ‘Time of flowering’.

20. The best case is case B in comparison to case A, but the reduction of workload is very small.

21. The conclusion is, for this example, that there are possibilities to reduce the number of plants but there is no general rule. Crop experts and statisticians need to look for effects on uniformity and distinctness simultaneously.

[End of document]