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STATISTICAL METHODS FOR VISUALLY OBSERVED CHARACTERISTICS

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EXECUTIVE SUMMARY

1.   The purpose of this document is to report on developments concerning "Statistical Methods for Visually Observed Characteristics".

2.   The TWA is invited to:

(a)   consider the presentations by members of the Union on how they intend to use the new statistical method for visually observed characteristics in DUS examination*;*

(b)   note that the TC, at its fifty-first session, agreed to remove the document "Statistical methods for visually observed characteristics" from the program for the revision of document TGP/8, and to consider the matter under a separate agenda item; and

(c)   note that the TWC invited an expert from China to make a presentation at its thirty-third session, to be held in Natal, Brazil, from June 30 to July 3, 2015, on the analysis of visually observed characteristics using the DUST China (DUSTC) software package using the data set of meadow fescue provided by Finland.

3.   The structure of this document is as follows:

4.   The following abbreviations are used in this document:

TC: Technical Committee
TC-EDC: Enlarged Editorial Committee
TWA: Technical Working Party for Agricultural Crops
TWC: Technical Working Party on Automation and Computer Programs
TWF: Technical Working Party for Fruit Crops
TWO: Technical Working Party for Ornamental Plants and Forest Trees
TWPs: Technical Working Parties
TWV: Technical Working Party for Vegetables

PURPOSE

5.   The purpose of this document is to report on developments concerning "Statistical Methods for Visually Observed Characteristics".

BACKGROUND

6.   The background to this matter is provided in documents TC/51/22 "Revision of document TGP/8: Part II: Selected Techniques Used in DUS Examination, New Section: Statistical Methods for Visually Observed Characteristics".

DEVELOPMENTS IN 2014

Technical Working Parties

7.   At their sessions in 2014, the TWO, TWF, TWV, TWC and TWA considered documents TWO/47/21, TWF/45/21, TWV/48/21, TWC/32/21, TWC/32/21 Add. and TWA/43/21 "Revision of Document TGP/8: Part II: Selected Techniques Used in DUS Examination, New Section: Statistical Methods for Visually Observed Characteristics", respectively.

8.   The Annex to document TWV/48/21 "Revision of Document TGP/8: Part II: Selected Techniques Used in DUS Examination, New Section: Statistical Methods for Visually Observed Characteristics" is reproduced in the Annex to this document.

9.   The TWO, TWF, TWC, TWV and TWA noted the developments concerning a possible New Section: "Statistical Methods for Visually Observed Characteristics" to be introduced in document TGP/8: Part II: Techniques Used in DUS Examination, in a future revision of document TGP/8 (see documents TWO/47/28 "Report", paragraph 47, TWF/45/32 "Report", paragraph 48, TWC/32/28 "Report", paragraph 45, TWV/48/43 "Report", paragraph 61 and TWA/43/27 "Report", paragraph 53, respectively).

10.   The TWO, TWF and TWV agreed that it should be clarified that the new proposed method was used for the visual observation of individual plants or parts of plants (VS) (see documents TWO/47/28, paragraph 48, TWF/45/32, paragraph 49 and TWV/48/43, paragraph 62, respectively).

11.   The TWC considered a comparison of the results on distinctness decisions between the new COYD method for visually observed characteristics and the Chi-square test, which was presented by an expert from Finland, as set out in the Annex to document TWC/32/21 Add. (see document TWC/32/28, paragraph 46)

12.   The TWC agreed that the new method was tailored for the analysis of visually observed characteristics and had a better fundamental basis when compared to the Chi-square test. The TWC noted that the new method allowed for distinctness to be established between more pairs of varieties than the Chi-square test in the example of meadow fescue "growth habit" considered (see document TWC/32/28, paragraph 47).

13.   The TWC agreed that software should be developed using the new method for the software packages available and noted that the code was currently available for SAS. The TWC noted the information that the United Kingdom was currently assessing how GenStat could be used for this method (see document TWC/32/28, paragraph 48).

14.   The TWC agreed to invite an expert from China to make a presentation on the analysis of visually observed characteristics using the DUST China (DUSTC) software package using the same data set of meadow fescue provided by Finland to be presented at the thirty-third session of the TWC (see document TWC/32/28, paragraph 49).

15.   The TWA noted the comparison of results of the COYD method for ordinal characteristics and Chi-square test on distinctness decisions made using meadow fescue growth habit data from Finland. The TWA agreed to request the TWC to clarify whether the COYD method for ordinal characteristics was recommended for any ordinal data or other conditions should also be considered when selecting the appropriate analysis method (see document TWA/43/27, paragraph 54).

DEVELOPMENTS IN 2015

Enlarged Editorial Committee

16.   The TC-EDC, held in Geneva, on January 7 and 8, 2015, considered document TC-EDC/Jan 15/12 "Revision of document TGP/8: Part II: Selected Techniques Used in DUS Examination, New Section: Statistical Methods for Visually Observed Characteristics".

17.   In order to achieve a better understanding of the new proposed method, the TC-EDC recommended that the members of the Union be invited to present to the TWPs how they intend to use the new method in DUS examination. In addition, the TC-EDC proposed to remove the document "Statistical methods for visually observed characteristics" from the program for the revision of document TGP/8, and the document to be presented under a separate agenda item, pending clarification on the possible use of the method.

Technical Committee

18.   The TC, at its fifty-first session, held in Geneva, from March 23 to 25, 2015, encouraged members of the Union to present to the TWPs the ways in which they intended to use the new statistical method for visually observed characteristics in DUS examination (see document TC/51/39 "Report", paragraph 154).

19.   The TC, at its fifty-first session, agreed to remove the document "Statistical methods for visually observed characteristics" from the program for the revision of document TGP/8 for the time being, and to consider the matter under a separate agenda item (see document TC/51/39, paragraph 155).

20.   The TC, at its fifty-first session, noted that an expert from China had been invited to make a presentation at the next session of the TWC on the analysis of visually observed characteristics using the DUST China (DUSTC) software package using the data set of meadow fescue provided by Finland (see document TC/51/39, paragraph 156).

21.   By means of a Circular issued on May 5, 2015, the TC and TWP members were invited to present to the TWPs, at their sessions in 2015, the ways in which they intend to use the new statistical method for visually observed characteristics in DUS examination (see Circular E-15/108). The presentations received will be provided as an addendum to this document.

22.   The TWA is invited to:

(a)   consider the presentations by members of the Union on how they intend to use the new statistical method for visually observed characteristics in DUS examination;

(b)   note that the TC, at its fifty-first session, agreed to remove the document "Statistical methods for visually observed characteristics" from the program for the revision of document TGP/8, and to consider the matter under a separate agenda item; and

(c)   note that the TWC invited an expert from China to make a presentation at the thirty-third session of the TWC on the analysis of visually observed characteristics using the DUST China (DUSTC) software package using the data set of meadow fescue provided by Finland.

[Annex follows]

ANNEX

**REVISION OF DOCUMENT TGP/8: PART II: TECHNIQUES USED IN DUS EXAMINATION,
NEW SECTION: STATISTICAL METHODS FOR VISUALLY OBSERVED2 CHARACTERISTICS**

**A COMPARISON OF THE RESULTS ON DISTINCTNESS DECISION BETWEEN THE COYD METHOD
FOR ORDINAL CHARACTERISTICS AND CHI-SQUARE TEST**

Introduction

1. During its 31st meeting in 2013, the TWC agreed that it would be beneficial to further develop the method for multinomial data and to compare the decisions made using the two methods Chi-square test and COYD method for multinominal characteristics, based on real data from Finland and the United Kingdom (Timothy, Red Clover and Meadow Fescue: growth habit). (See report TWC/31/32 page 7.)

2. A Comparison of the results of the COYD method for ordinal characteristics and Chi-square test on distinctness decision was made using the same Meadow fescue growth habit data from Finland. The idea of the comparison is to consider if the COYD for ordinal characteristics separates more variety pairs than the Chi-square test. As an expert from Denmark stated in the Memorandum (TC/50/28, Annex, page 2.) 'The Chi-square test does not depend on the scale of measurements, so data recorded on the nominal scale and ordinal scale are treated the same way and because the Chi-square test ignores the ordering of notes on the ordinal scale. The proposed new method for characteristics recorded on the ordinal scale takes this ordering into account. The proposed method is therefore expected to be more effective if the data are recorded on the ordinal scale than if they are recorded on the nominal scale.'

3. Introduction to different types of data and scale levels, including ordinal scaled quantitative data, can be found in the revision document for TGP/8 'Data to be recorded' (latest version TC/50/5 Annex II). Detailed analysis of COYD method for ordinal characteristics by expert from Denmark in TC/49/32 Annex II, pages 4 to 10). Pearson's chi-square test is explained in TGP/8/1 Part II, page 85.

4. The characteristic 'Plant: growth habit at inflorescence emergence' (TG/39/8 Meadow fescue (*Festuca pratensis* Huds and Tall fescue *F.arundinacea* Schreb.) is a visually observed characteristic TG/39/8 explains the characteristic 'The growth habit should be assessed visually from the attitude of the leaves of the plant as a whole. The angle formed by the imaginary line through the region of greatest leaf density and the vertical should be used.' . The observations for this data were done from single plants and the observer gave each one a note.

Criteria for distinctness in the Chi-square test

5. The p-value used in the Chi-square test was 0,05. Yates correction was not used, because the amount of classes in the comparison was always over two.

6. The order of direction of the data was checked before distinctness decision, i.e. the growth habit of the candidate has to be constantly more erect or more prostrate than the compared reference in at least two of the three years used in the analysis. If the data compared between variety pair had different directions in different years, the result was not distinct even though the calculated p-values were under 0,05 in both of the years.

7. The recommended criteria for Chi-square test was used (Ranta et al. 1994). Therefore 20% of the calculated expected frequencies shouldn't go under 5 and the expected frequencies should be over 1. Due to this, some of the classes had to be fused together. It was usual to have four to three classes in the analysis, because otherwise these criteria would not have met. Especially more extreme classes 1 to 3 and 6 to 9 had only few observations (see TC/49/32, Annex II, page 8).

8. The analyses for Chi-square test were done using Excel software for Windows.

Results and conclusions

9. Candidate A could be separated from 6 reference varieties with Chi-square test (varieties F,H,K,P,W and 1). Candidate B was separated from 3 reference varieties (F,P and 1). COYD method for ordinal characteristics separated respectively 11 reference varieties from Candidate A (varieties E,F,H,K,N,P,U,V,Z,1 and 3) and 10 reference varieties from Candidate B (varieties E,F,H,K,N,P,U,V,Z and 3). In average, the COYD method separated 20% more reference varieties than the Chi-square test. For Candidate A, all the reference varieties separated by Chi-square test

except one (candidate W) were separated also by COYD method. For Candidate B there was also one reference variety (candidate 1) separated only by Chi-square test.

10. Problem of the analysis of growth habit data with Chi-square test is the low number of individuals in some of the classes. In 14 cases the p-values in comparisons with Candidate A were under 0,05, but the expected frequencies didn't fulfill the requirements (either over 20% of the expected frequencies were under 5 or some of the values were under 1). Comparisons with Candidate B showed 5 similar situations (marked as (* in the Table 1. in the Annex). This low number of observations in some classes can lead into situation where the candidate variety can't be stated as distinct, because the requirements of the statistical analysis are not fulfilled, though the compared varieties could be distinct.

11. The comparison of the results of COYD method for ordinal characteristics and Chi-square test for meadow fescue growth habit data showed that COYD method for ordinal characteristics can separate more varieties and therefore the use of COYD method with ordinal characteristic would enhance decisions on distinctness.

12. It would be useful to have same type of comparison between COYD method for multinomial characteristics and Chi-square test with other species and characteristics.

References

Ranta, E., Rita, H. & Kouki J. 1994. Biometria. Tilastotiedettä ekologeille. Yliopistopaino, Helsinki.

UPOV. TGP/8/1. Trial Design and Techniques Used in the Examination of Distinctness, Uniformity and Stability. 2010

UPOV TG/39/8 Guidelines for the conduct of tests for distinctness, uniformity and stability. Meadow fescue (*Festuca pratensis* Huds.), Tall fescue (*Festuca arundinacea* Schreb.). Geneva 2002.

TC/50/28 REVISION OF DOCUMENT TGP/8: PART II: SELECTED TECHNIQUES USED IN DUS EXAMINATION, NEW SECTION: STATISTICAL METHODS FOR VISUALLY OBSERVED CHARACTERISTICS, January 30, 2014.

TC/49/32 REVISION OF DOCUMENT TGP/8: PART II: SELECTED TECHNIQUES USED IN DUS EXAMINATION, NEW SECTION: STATISTICAL METHODS FOR VISUALLY OBSERVED CHARACTERISTICS, February 4, 2013.

Annex. Table 1. P-values for variety pair comparisons and information of distinctness by Chi-square test and COYD for ordinal characteristics.

Ref. Variety	CANDIDATE A			Distinct by Chi-square test	Distinct by COYD	CANDIDATE B			Distinct by Chi-square test	Distinct by COYD
	2010	2011	2012			2010	2011	2012		
cand A	-	-	-	no	no	0,02(*	0,38	0,31	no	no
cand B	0,02(*	0,53	0,31	no	no	-	-	-	no	no
C	0,68	0,16	0,86	no	no	0,31	0,12	0,67	no	no
D	0,24	0,04(*	0,06	no	no	0,25	0,74	0,88	no	no
E	0,003	0,07	0,07	no	**D**	0,0003	0,46	0,09	no	**D**
F	0,04(*	**0,0001**	**0,002**	**D**	**D**	0,74	0,002	0,005	**D**	**D**
G	0,01	0,64	0,06	no	no	0,14	0,80	0,02	no	no
H	**0,00002**	0,0003(*	**0,03**	**D**	**D**	0,0006(*	0,16	0,01	no	**D**
I	0,40	0,77	0,85	no	no	0,01	0,33	0,66	no	no
J	0,34	0,21	0,16	no	no	0,01	0,17	0,68	no	no
K	0,13	**0,001**	**0,04**	**D**	**D**	0,43	0,09	0,07	no	**D**
L	0,14	0,40	0,27	no	no	0,15	0,76	0,65	no	no
M	0,18	0,33	0,21	no	no	0,39	0,07	0,95	no	no
N	0,09	0,0005	0,07	no	**D**	0,28	0,04(*	0,03	no	**D**
O	0,007 D	0,005(*	0,02 D	no	no	0,02	0,65	0,26	no	no
P	0,001(*	**0,0004**	**0,01**	**D**	**D**	0,001	0,09	0,002	**D**	**D**
Q	0,01	0,51	0,15	no	no	0,03	0,42	0,48	no	no
R	0,26	0,54	0,08	no	no	0,53	0,42	0,17	no	no
S	0,007(*	0,15	0,16	no	no	0,03	0,24	0,78	no	no
T	0,22	0,001	0,85	no	no	0,46	0,46	0,69	no	no
U	0,0008	0,01(*	0,08	no	**D**	0,007	0,58	0,18	no	**D**
V	0,30	0,004(*	0,40	no	**D**	0,66	0,39	0,06	no	**D**
W	0,15	**0,03**	**0,04**	**D**	no	0,24	0,22	0,13	no	no
X	0,02(*	0,009 (*	0,13	no	no	0,01(*	0,67	0,45	no	no
Y	0,47	0,35	0,14	no	no	0,20	0,63	0,82	no	no
Z	0,04(*	0,02(*	0,04	no	**D**	0,01(*	0,37	0,01	no	**D**
1	**0,004**	**0,0001**	**0,02**	**D**	**D**	0,02	0,14	0,03	**D**	no
2	0,39	0,15	0,14	no	no	0,39	0,43	0,22	no	no
3	0,32	0,22	0,10	no	**D**	0,04	0,32	0,72	no	**D**
4	0,17	0,01	0,09	no	no	0,13	0,47	0,46	no	no
5	0,05(*	0,27	0,02	no	no	0,73	0,17	0,47	no	no

Explanations for the table

(* p-values which were under 0,05, but over 20 % of the the expected frequencies were under 5 or one or more of the expected frequencies were below 1

d the direction of the difference between varieties was not constant between years

highlighted p-values in shaded cells are p-values which separated varieties,

D is for distinct

[End of Annex and of document]