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COMPARISON OF COYU AND A METHOD BASED ON BENNETT'S TEST FOR COEFFICIENTS OF VARIATION

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COMPARISON OF COYU AND A METHOD BASED ON BENNETT'S TEST FOR COEFFICIENTS OF VARIATION

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Summary

1. In documents TWC/23/9 and TWC/24/7 the conclusions concerning uniformity of rye varieties based on the UNIF (COYU) approach and on the Bennett's test were compared. The decisions were generally similar but in some cases differences appeared.

2. During the discussion at the twenty-fourth session of the TWC, held in Nairobi, from June 19 to 22, 2007, it was suggested to perform additional comparisons of the two methods. The additional comparisons were intended to investigate if there was a relationship between the degree of correlation between the expression of characteristic and log transformed values of its standard deviations and decisions concerning uniformity supported by the two methods. It was also suggested to apply McNemar's test instead of a test of independence. In this document these problems are addressed.

Introduction

3. In Poland, decisions concerning DUS are based on results of field (greenhouse as well) trials performed usually at one location for three years. One of the officially accepted and promoted methods of checking uniformity for cross-pollinated varieties is the COYU method. In the COYU approach, the log transformed and adjusted by moving average method, values of standard deviations of new varieties are compared with similar (averaged) values calculated for varieties treated as standards. Such comparisons are made for all characteristics observed (measured) in DUS trials. If values for a new variety do not significantly exceed average values of "old" varieties (forming so-called reference set) for all characteristics under consideration, the new variety is accepted and in the next cycles it can become a member of the reference set.

4. Because sample standard deviations sometimes depend on the levels of expression of the characteristic under consideration, some additional procedures have been elaborated to remove those influences. The COYU method is used by many UPOV members. Another possible approach is the use of a somewhat different measure of uniformity based on the coefficient of variation. Such a new approach was described in documents TWC/23/9 and TWC/24/7. The equality of coefficients of variation for the new (candidate) variety and of varieties belonging to the reference set can be tested using the Bennett's test which is much simpler than COYU. The new method was applied to three years of results obtained from rye trials. Because decisions concerning uniformity were slightly different it was suggested to check if those discrepancies were related to existing relationships between levels of expression of observed characteristics and values of (log transformed) standard deviations. This document assesses that aspect.

Data

5. The same data as in documents TWC/23/9 and TWC/24/7 are used. Data concern 73, 83 and 75 varieties tested in 1999, 2000 and 2001, respectively, in DUS trials performed at Variety Testing Experimental Station at Słupia Wielka, Poland.

6. The details of those experiments are provided in documents TWC/23/9 and TWC/24/7. There were eight measured characteristics, namely (characteristic codes taken from UPOV Test Guidelines): 31. Plant height; 32. Length between upper node and ear; 33. Length of ear; 10. Length of blade of leaf next to flag leaf; 11. Width of blade of leaf next to flag leaf; 51. Number of spikelets; 52. Length of rachis. All the calculations were performed using mean values and standard deviations calculated over 40 single plant measurements.

7. To have an orthogonal set of data from three years of trialing, only a subset of twelve new (candidate) varieties and a subset of 19 old varieties (forming the reference set) were taken into consideration. Many other characteristics were also observed, but because they were qualitative in nature, they were excluded from statistical analysis.

Method

8. In order to find an explanation of the discrepancies between the conclusions concerning uniformity provided by the two methods under comparison, the following approach was applied. Before the application of analysis of regression of standard deviations on mean values, the standard deviations s_d were transformed using $\log(s_d+1)$ transformation. That is the same transformation as used in the COYU approach (see document TWC/18/10).

9. Then, all the cases were split into three classes, the *highly significant* situation when there was significance of regression of $\log(s_d+1)$ values on mean values at $\alpha < 0{,}01$ level, the *significant* situation, when regression was significant at $\alpha < 0{,}05$ but not at $\alpha < 0{,}01$, and the situation of *lack of significance* at $\alpha = 0{,}05$ level. For each of these situations, the numbers of all positive decisions (acceptance of variety as uniform) and negative decisions (rejecting of variety as non-uniform) across all characteristics were counted. The two-by-two contingency tables were formed, with two rows reflecting decisions taken by COYU method and with two columns reflecting decisions supported by the Bennett test. For those tables the McNemar's test was applied, McNemar (1947).

10. If n_{11} and n_{22} represent the number of cases where the two methods under comparisons resulted in the same decisions concerning uniformity and lack of uniformity, and respectively n_{12} and n_{21} the number of cases with contradictory decisions, the hypothesis tested was of the form
$H_0 : n_{12}=n_{21}$ against alternative $H_1: n_{12} \neq n_{21}$.

The McNemar statistic takes a form

$$Q_M = (n_{12}-n_{21})^2/(n_{12}+n_{21})$$

and is distributed as χ^2 with one degree of freedom.

Results

11. The method described above was applied to the rye data. The data were analyzed twice. First, the two procedures of the DUST package (see Weatherup 1992), namely UNIF and COYU were applied and, secondly, the same data were analyzed using the Bennett test for coefficients of variation. The conclusions on uniformity were then compared on a characteristic-by-characteristic basis.

12. The results are presented in Table 1. Two additional cases are distinguished in that Table, the first is called "Bennett (10)", the second "Bennett (whole)". The first case reflects the situation when every candidate variety was tested against a subset of ten reference varieties with the closest mean values, while in the second case all varieties from the reference set were taken into account (for details see Zawieja and Pilarczyk (2006)).

13. Calculations were performed independently for 1999, 2000 and 2001 and also for the whole data set. For yearly data, the UNIF procedure of DUST package was applied; for over-years analysis the COYU procedure was used. For total data there were no significant differences (all the test were performed at $\alpha = 0.05$ and $\alpha = 0.01$ significance levels) between decisions supported by COYU and by Bennett (10) approach.

14. The Bennett (whole) approach gave slightly more positive decisions (more varieties accepted as uniform) than the COYU approach only in those situations when there was a highly significant linear relationship between mean values and transformed values of standard deviations. The McNemar test was significant at $\alpha = 0.05$ level.

15. When testing was performed on a yearly basis, for cases with a highly significant relationship between means and standard deviations, the conclusions supported by the Bennett test were in all cases significantly different than those supported by the UNIF approach (again by the Bennett test more varieties were indicated as uniform). When there was no linear relationship, the conclusions were quite similar.

Table 1

Differences between conclusions (tested by McNemar test) depending on significance of regression between mean values and log transformed standard deviations

	Bennett (10)			Bennett (whole)			Bennett (10)	Bennett (whole)
Significance of regression	Year			Year			All years	All years
	1999	2000	2001	1999	2000	2001		
**	*	**	**	**	*	**	ns[x]	*
*		ns			ns		ns	ns
ns		ns			**		ns	ns

[x] ns stands for lack of significance at α=0,05 level

Comments and Conclusions

16. The analysis of rye data from official DUS trials on rye in Poland showed that when there is no significant relationship between levels of expression of the characteristics (mean value) and between-plants standard deviations, the conclusions concerning uniformity are statistically the same, independently of the procedure applied (UNIF and COYU or the Bennett test). When there are such relationships, the Bennett test more often declares varieties uniform. Further comparisons with the use of other data are needed to conclude more generally about the behaviour of these two approaches in the assessment of uniformity.

References

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