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FURTHER COMPARISON OF DECISIONS CONCERNING UNIFORMITY OF RYE VARIETIES BASED ON COYU APPROACH AND ON BENNETT'S TEST

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Summary

Uniformity of new varieties are usually checked using COYU approach after collecting results of three years of trials. There are some other possibilities of testing uniformity as indicated in a papers by Zawieja and Pilarczyk (2005, 2006). In this paper the discrepancies between the decisions concerning uniformity of rye varieties taken with the support of two methods (COYU and Bennett's test) are compared. The influence of degree of correlation between levels of expression of characteristics (mean values) and transformed standard deviations on the decisions concerning uniformity is investigated.

Key words and phrases: Bennett's test, coefficient of variation, DUS testing, uniformity

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1. Introduction

Every new variety of any cultivated crop before being allowed to enter the market must prove its distinctness, uniformity and stability (DUS). Distinctness

means that variety must be distinguishable from each other variety by at least one characteristic. Uniformity in turn means that plant to plant variability for that variety must not exceed such variability observed for all already existing varieties (varieties of common knowledge). And finally term stability denotes here that all phenotypic features (characteristics) of variety must be transmitted from one generation to another. Decisions concerning DUS are based on results of field (greenhouse as well) trials performed usually at one location for three years. International co-operation in this field is co-ordinated by UPOV (International Union for Protecting Varieties of Agricultural Crops). One of officially accepted and promoted methods of checking uniformity is so-called COYU (combined over years uniformity) method. In this 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 new variety do not exceed significantly average values of "old" varieties (forming so-called reference set) for all characteristics under consideration, the new variety is accepted and in next cycle it is a member of the reference set. COYU method is used in majority member states of UPOV. It is a slightly sophisticated method and one of possibilities of replacing it is for example application of a little different measure of uniformity based on coefficient of variation. Equality of coefficients of variation for new (candidate) variety and of varieties belonging to reference set can be tested using much simpler than COYU Bennett test. Such approach has been proposed in a papers by Zawieja and Pilarczyk (2005, 2006). This new approach was presented also at two last annual meetings of UPOV TWC (Technical Working Party for Automation and Computer Programs). Because decisions concerning uniformity were slightly different it was suggested to check if these discrepancies are related to existing relationships between levels of expression of observed characteristics and values of (log transformed) standard deviations. This papers deals with this problem.

2. Data

The same data as in a papers by Zawieja and Pilarczyk (1005, 2006) 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. The details of these experiments are given in mentioned above

papers. There were eight measured characteristics, namely (codes of characteristics taken from UPOV 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. To have orthogonal set of data from three years of trialing, only subset of twelve new (candidate) varieties and subset of 19 old varieties (forming the reference set), were taken into consideration.

3. Method

Looking for explanation of discrepancies between decisions concerning uniformity given by two methods under comparisons the following approach was applied. Before application of analysis of regression of standard deviations on mean values the standard deviations s_d were transformed using $\log(s_d + 1)$ transformation. It is the same transformation as used in COYU (see Talbot, 2000) approach. Then all the cases were split into three classes, highly significant situation when there was significance of regression of $\log(s_d+1)$ values on mean values at $\alpha < 0{,}01$ level, 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 every of these situations the number of all positive decisions (acceptance of variety as uniform) and negative decisions (rejecting of variety as non-uniform) across all characteristics was counted. So the two by two contingence tables were formed, with two rows reflecting decisions taken by COYU method and with two columns reflecting decisions supported by Bennett test. For these tables the McNemar's test was applied (McNemar, 1947). If n_{11} and n_{22} mean the number of cases that 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 has a form

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

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

4. The results

The described above method was applied to rye data. The data were analysed twice. At first, the two procedures of DUST package (see Weatherup, 1992), namely UNIF and COYU were applied and next the same data were analysed using Bennett test for coefficients of variation and, finally, the decisions on uniformity were compared on characteristic by characteristic basis. The results are collected in Table 1.

Table 1. Differences between decisions (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

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 subset of ten reference set varieties with closest mean value, while in the second case all varieties from reference set were taken into account (for details see Zawieja and Pilarczyk, 2006). Calculations were performed independently for 1999, 2000 and 2001 years and also for joint data. For yearly data the UNIF procedure of DUST package was applied, for over years analysis the COYU procedure was used. It is easy to notice that for joint data there was no significant differences (all the test were performed at $\alpha = 0.05$ and $\alpha = 0.01$ levels) between decisions supported by COYU and by Bennett (10) approach. The Bennett (whole) approach gave slightly more positive decisions (more varieties accepted as uniform) than COYU approach only in these situations when there was highly significant linear relationship between mean values and transformed values of standard deviations. The McNemar test was significant at $\alpha = 0.05$ level. When testing was

performed on annual basis, for situation of highly significant relationship between means and standard deviations, the decisions supported by Bennett test were in all cases significantly different than those supported by traditional approach (again by Bennett test more varieties were indicated as uniform). When there was no linear relationship the decisions were quite similar.

5. Comments and conclusions

The performed analysis of rye data from official DUS trials on rye in Poland shoved that when there is no significant relationship between levels of expression of analysed characteristic (mean value) and between plants standard deviations, the decision concerning uniformity are statistically the same independently of applied procedure (UNIF and COYU or Bennett test). When there is such relationships the Bennett test seems to be more tolerant, it means that more often declares varieties uniform. Further comparisons with use other data are needed to conclude more generally about behaviour of these two approaches to testing of varietal uniformity.

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DALSZE PORÓWNANIE DECYZJI O WYRÓWNANIU ODMIAN ŻYTA PODJĘTYCH PRZY ZASTOSOWANIU METODY COYU I TESTU BENNETTA

Streszczenie

Decyzję o wyrównaniu odmian podejmuje się zwykle wykorzystując metodę COYU po przeprowadzeniu trzech lat doświadczeń. W pracach Zawieji i Pilarczyka (2005, 2006) została zaproponowana nowa metoda badania wyrównania odmian, polegająca na zastosowaniu testu Bennetta. W niniejszej pracy porównano różnice pomiędzy decyzjami dotyczącymi wyrównania odmian żyta podjętych po zastosowaniu metody COYU i testu Bennetta. Badano różnice między decyzjami o wyrównaniu w zależności od stopnia skorelowania wartości średnich i transformowanych odchyleń standardowych.

Słowa kluczowe: badania OWT, test Bennetta, współczynnik zmienności, wyrównanie odmian

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