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TWC/23/8
ORIGINAL: English
DATE: May 15, 2005

UPOV

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

A PROPOSAL FOR AN ADJUSTMENT TO THE COYD METHOD WHEN VARIETIES ARE GROUPED WITHIN THE DUS TRIAL

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Background

1. In some crops, it is possible to use grouping characteristics to define groups of varieties such that all the varieties within a group will be distinct from all the varieties of any other group ("distinct groups"). This grouping is preserved in trial layouts so that, within a replicate, varieties in the same group are adjacent. (See TG/1/3, section 4.8 "Functional Categorization of Characteristics). Field pea is an example of such a crop.

2. The current method of analysis used in field pea is to apply analysis of variance for a randomised complete block design for each trial and then apply COYD (also analysis of variance) to the variety-by-trial means. This takes no account of the grouping, although semi-leafless and conventional types are analysed separately because they are distinct types. In some crops, different groups are analysed separately but in pea many groups are too small.

3. In this paper we propose an adjustment to the COYD method that is both effective and that should be relatively simple to implement.

The idea

4. When grouping is possible, such that all the varieties within a group will be distinct from all varieties of any other group ("distinct groups"), comparisons are only necessary between varieties in the same group. In principle, it would be possible to analyse groups separately; in practice some groups have too few varieties. Instead we propose that the over-years analysis of variance (COYD) be adjusted to take into account the group-by-year interaction.

5. So whereas the standard COYD has terms for 'year' and 'variety', the adjusted form has terms for 'year', 'group', 'variety-within-group' and 'group-by-year'. The standard error (and LSD) is then calculated for differences between pairs of varieties within the same group. Note we assume that the same standard error is applicable within all groups.

Some detail

6. With COYD, the analysis of variance is based on variety-by-year means for two or three years depending on the crop. Usually only varieties present in all years are considered (not for cyclic planting). The analysis of variance includes effects for year and variety. The standard error, SED_{COYD}, for the difference between two varieties is given by:

$$SED_{COYD} = \sqrt{\frac{2}{n} RSS_{COYD}}$$

where n is the number of years and RSS_{COYD} is the residual sum of squares from the analysis of variance (based on means).

7. We propose that an extra factor, the group-by-year interaction, is included in the analysis of variance. So in GenStat terminology we have:

Block structure: Year + Year.Group

Treatment structure: Group/variety

The standard error, SED_{adj}, for the difference between two varieties in the same group is given by:

$$SED_{adj} = \sqrt{\frac{2}{n} RSS_{adj}}$$

where RSS_{adj} is the residual sum of squares from the analysis of variance that includes the group-by-year interaction term. Unlike SED_{COYD}, SED_{adj} excludes variability due to the interaction between varietal groups and years. We believe this is reasonable as candidate varieties are only being assessed for distinctness with varieties in their group. Note that SEDs for comparisons between varieties in different groups are more difficult to calculate.

Application

8. This adjustment method has been applied to UK field pea DUS trial data from 1995-2004. Comparisons were made between standard COYD and the group-adjusted COYD on pairs of consecutive years. Semi-leafless and conventional varieties were analysed separately. Only one group was represented in 2002-3 and 2003-4 for the conventional type so these were not analysed.

9. Tables 1 and 2 show the decreases in the standard errors (or LSDs) for the semi-leafless and conventional types respectively. Characteristic descriptions are shown in Table 3.

10. In nearly all cases (81% for semi-leafless and 73% for conventional), there is a decrease in the standard error when the adjustment is used. These correspond to cases where there is a group-by-year effect (results not shown). Often the reduction is sizeable. In those cases where there is no reduction, the increase in standard error is generally negligible. A notable exception is for conventional varieties in 2000-1. We suggest that this is partly due to the low number (7) of residual degrees of freedom for the adjusted method in this case.

Conclusions

11. We have proposed a method for adjusting COYD when grouping characteristics are used to identify distinct groups of varieties. It is appropriate when group sizes are too small to allow separate analyses. Application to a number of datasets for field pea has shown that this should produce considerable benefits for some characteristics. The method should not be used if the resulting degrees of freedom drops to below, say, 12. This method should be relatively easy to implement.

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Table 1: *Reduction in SED given by the adjusted-COYD method compared to the standard COYD method: semi-leafless varieties*

	Pairs of years								
	95-6	**96-7**	**97-8**	**98-9**	**99-0**	**00-1**	**01-2**	**02-3**	**03-4**
No. varieties	99	111	129	118	147	148	157	170	148
No. groups	7	10	12	6	9	8	8	10	9
Min. no. per group	1	1	1	1	1	2	1	1	1
Max. no. per group	57	64	76	71	93	93	113	124	105
Characteristic	**SED decrease from conventional COYD to group-adjusted COYD (%)**								
01	10.3	8.1	12.5	0.3	-0.9	1.4	1.4	0.4	0.5
03	0.1	5.5	7.2	7.5	4.6	8.8	1.9	2.9	-0.3
07	3.8	18.1	1.8	12.3	9.1	5.7	3.5	2.9	-2.4
10	2.9	0.3	5.3	7.3	2.7	2.2	1.4	3.0	1.6
12	4.1	7.4	11.4	6.3	2.5	2.0	4.5	5.8	7.4
25	4.0	6.6	6.4	3.5	16.2	5.0	0.3	5.9	1.5
41	19.5	19.7	2.1	10.1	5.0	3.1	3.1	6.5	1.9
44	12.2	21.5	1.8	13.8	1.8	2.1	5.2	6.7	3.3
46	12.0	37.3	18.4	3.0	7.2	2.6			
71	3.4	-0.2	11.2	1.4	6.4	12.6	6.6	0.6	2.3
74	-1.2	7.9	2.9	0.7	4.4	3.5	2.9	-1.1	-0.6
75	3.4	18.9	11.9	1.9	9.8	7.6	4.8	2.2	-0.4
76	6.1	7.8	1.2	1.0	2.7	2.0	3.2	-0.2	1.2
80		25.2	12.4	4.1	1.1	22.5	3.8	8.7	3.7
88			3.5	10.6	1.3	0.5	0.8	4.6	8.3

Table 2: *Reduction in SED given by the adjusted-COYD method compared to the standard COYD method: conventional varieties*

	Pairs of years						
	95-6	**96-7**	**97-8**	**98-9**	**99-0**	**00-1**	**01-2**
No. varieties	27	14	19	28	18	11	19
No. groups	5	3	3	4	2	4	3
Min no. per group	2	1	1	3	7	1	1
Max no. per group	13	8	11	13	11	6	13
Characteristic	**SED decrease from conventional COYD to group-adjusted COYD (%)**						
01	-4.4	-0.9	16.7	2.8	6.4	19.5	1.1
07	20.9	-2.5	7.9	21.6	39.9	21.0	13.6
10	9.3	16.9	15.3	22.3	45.8	18.9	26.6
12	11.9	16.4	7.7	12.3	34.1	24.9	32.6
25	8.1	-1.9	18.6	0.6	32.2	31.4	0.3
36	22.3	-0.7	1.0	3.5	2.7	13.4	-3.8
41	17.6	21.8	7.1	6.4	11.1	38.9	26.5
44	0.3	25.6	8.8	8.9	0.0	7.0	27.6
46	13.7	20.8	6.1	27.5	10.1	-9.1	1.6
50	33.1	10.9	13.3	-2.2	14.2	32.9	12.7
51	36.4	23.3	12.6	3.2	5.6	44.2	11.7
71	14.9	-6.3	0.4	-1.9	38.9	1.9	7.4
72	1.0	-4.7	-2.4	11.5	-0.9	-8.4	9.6
74	7.1	-2.1	-0.2	19.8	37.3	-11.2	10.4
75	23.8	4.2	-1.2	2.0	28.5	1.0	-3.8
76	17.7	-2.3	-1.0	-1.3	-3.1	1.3	-4.5
80	24.9	5.3	15.6	-2.9	-2.7	-4.6	13.2
88			11.9	6.2	-1.7	47.6	-3.2

Table 3: *Descriptions of pea characteristics*

Characteristic	**Description**
01	Plot height at 80% flowering
03	Petiole length
07	Peduncle length (stem to first pod)
10	Days to first flower
12	Days to 80% flowering
25	Flower standard width
36	Leaflet widest point to base
41	Stipule length
44	Stipule width
46	Foliage colour (intensity)
50	Leaflet length
51	Leaflet width
71	Number of nodes up to first fertile node
72	Maximum leaflet number
74	Pod length
75	Pod width
76	No seeds & ovules per pod
80	100 Seed weight (dry)
88	Plot height at harvest

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