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THE EFFICIENCY OF INCOMPLETE BLOCK DESIGNS IN DUS TRIAL ON PEA VARIETIES

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THE EFFICIENCY OF INCOMPLETE BLOCK DESIGNS IN DUS TRIAL ON PEA VARIETIES

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Summary

The efficiency of different designs in experiment on pea varieties has been investigated on the basis of the results of a pea trial conducted for DUS purposes at the experimental station Słupia Wielka, Poland, in 2000. Because of the shape of the experimental field and its equipment (wire netting running down the middle of 14 neighbouring plots), the experiment was established in a row-column design. The variances of experimental error are compared for different factors (rows or columns or both) included in the mathematical models of observations.

1. Introduction

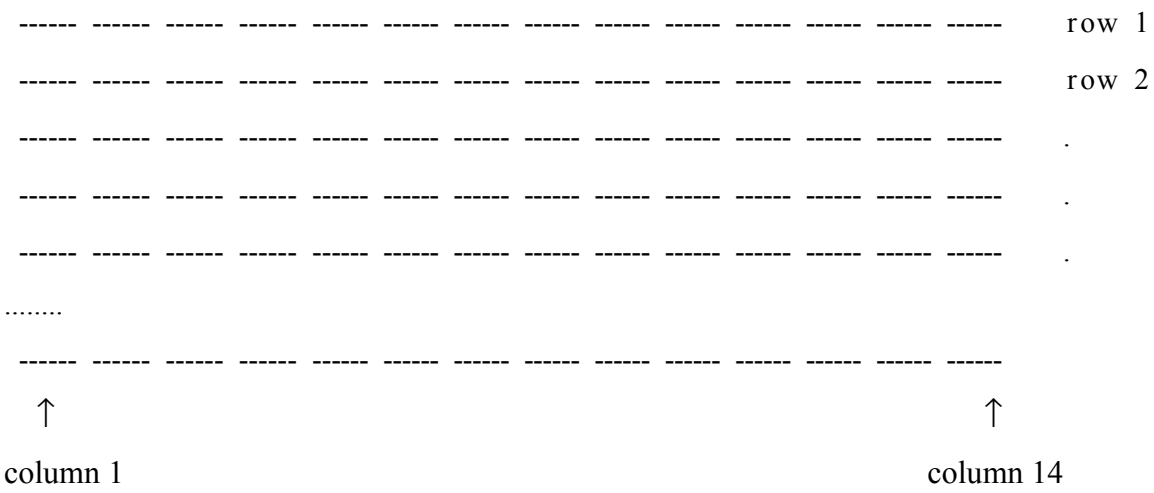
Incomplete blocks have been widely used for many years in VCU trials in many countries as they have proved their advantage over complete blocks, Patterson and Hunter [1983], Pilarczyk [1991]. Lately, some attempt can be observed towards use of these designs also in DUS trials. For example Kristensen [1998, 1999, 2000] reported the efficiency of resolvable incomplete block designs in DUS trial on spring rape, winter rape and yellow mustard conducted in Denmark, whereas Pilarczyk [1999, 2000] reported relatively low efficiency of such designs in experiments conducted in Poland on French bean and field pea.

2. Description of an experiment

In an experiment on pea varieties conducted at the variety testing experimental station at Słupia Wielka in 2000, 111 varieties were compared. The experiment was established in a kind of row-column design in two replicates. The plots were arranged into rows (referred to as blocks). Each row comprised 14 plots. There was wire netting running down the middle of the plots along the rows. Rows in the experimental field ran in parallel lines. After every fourth row a free space (path) was left, thus the plots formed row-column design with rows consisting of 14 plots. The field scheme is illustrated in Fig. 1. The plots were 3 m in length and 1.5 m wide. Every row was 42 meters long. Varieties were randomized according to restrictions imposed by a row-column design. Plants were sown on one side of the wire netting at 5 cm distance from each other. There were 60 plants sown in each plot. Additional guard plots were placed on all sides of the experiment, and additional gaps of 15 cm between plots were also introduced. From every plot 15 plants were chosen at random and all measurements were made on these plants. In this way, there were in total 30 measurements for every variety.

Figure 1

Arrangement of plots in the experimental field in the pea trial



3. The data and the results of analysis

As mentioned earlier, 30 plants for every variety were measured. Some characteristics included in UPOV Test Guidelines were observed and some additional characteristics as well. All the analyses were performed for the following characteristics:

Number	UPOV number	Description of characteristics
C1	12	stem length
C2	---	stem length up to first fertile node
C3	---	length of inter-node between first an second fertile node
C4	13	number of nodes up to and including first fertile node
C5	48	pod length
C6	49	pod - maximum width
C7	60	pod - number of ovules

For every characteristic in turn the analyses of variance were performed according to the following models of observations (see Table 1 below):

CB	completely randomized design
RCB	randomized complete blocks design
IB	rows – incomplete blocks with rows as blocks
IB	resolvable – incomplete blocks with rows as blocks grouped into complete superblocks
IB	columns – incomplete blocks with columns as blocks
IB (R+C)	incomplete row-column design.

The results of performed analyses are summed up in Table 1 (below). In column E, the mean harmonic efficiency factors are given for the respective designs. These are equal to 1 for complete (orthogonal) designs and are smaller than 1 for incomplete blocks. In Table 1 the mean squares for error (MS_e) received for different designs are given.

Table 1

Mean squares for error of different (complete and incomplete) block designs in DUS trial on pea for different characteristics

Design	E	Characteristic						
		C1(12)	C2(---)	C3(---)	C4(13)	C5(48)	C6(49)	C7(60)
CR	1	301.5	187.5	2.470	5.791	0.2952	0.9295	0.6534
RCBD	1	293.1	189.3	2.441	5.864	**0.2946**	0.9417	0.6617
IB-Rows	0.8862	**269.9**	**183.5**	**2.395**	6.269	0.3016	0.9472	0.6915
IB-Columns	0.8862	325.0	186.0	2.592	**5.583**	0.3083	**0.9108**	0.6564
IB-(R+C)	0.8900	304.7	191.5	2.664	6.312	0.3272	0.9521	**0.6513**
IB–resol.	0.8838	272.0	185.9	2.432	6.278	0.3059	0.9597	0.6963

Ci(jj) means characteristic number i, jj – characteristic number according to UPOV Test Guidelines whereas --- denotes characteristics not included in the UPOV Test Guidelines

From a practical point of view, the variances of simple contrasts between varieties are more interesting. These values are collected in Table 2. The smallest values in both Tables are given in bold print. In Table 2 the upper values mean average variances of treatment contrast in the fixed model of observation whereas the lower values mean the same but in the mixed model of observation (analysis with recovery of inter-block information).

Table 2

Average variances of treatment comparisons in different (complete and incomplete) block designs in DUS trial on pea for different characteristics

Design	E	Characteristic						
		C1(12)	C2(---)	C3(---)	C4(13)	C5(48)	C6(49)	C7(60)
CR	1	19.70	15.53	1.783	**2.730**	0.6164	**1.094**	**0.9170**
RCBD	1	19.44	15.62	**1.774**	2.750	0.6164	1.102	0.9237
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IB-Rows	0.8862	21.89	18.06	2.062	3.337	0.7320	1.297	1.108
		19.43	**15.52**	1.782	2.812	**0.6158**	1.099	0.9370
IB-Columns	0.8862	22.52	17.04	2.012	2.952	0.6938	1.192	1.012
		20.66	15.80	1.812	**2.730**	0.6327	**1.094**	0.9287
IB-(R+C)	0.8900	26.37	20.91	2.466	3.795	0.8641	1.474	1.219
		20.45	15.79	1.812	2.812	0.6323	1.099	0.9512
IB – resol.	0.8838	22.68	18.90	2.162	3.473	0.7666	1.358	1.157
		19.43	15.60	1.788	2.794	**0.6158**	1.101	0.9353

Ci(jj) have the same meaning as in Table 1.

It is easy to notice that for characteristics C1, C2, C3, C4, C6 and C7 smaller mean squares for error in incomplete blocks with either rows or columns as blocks were received, but the gain in comparison with complete blocks was too small to compensate for the decreasing of the mean harmonic efficiency factor E. For two characteristics involved (C3 and C7), the variance of treatment comparisons was the smallest for randomized complete blocks or for completely randomized design. Incomplete blocks analyses with either rows or columns used as incomplete blocks were for five characteristics (C1, C2, C4, C5 and C6) at a similar level of efficiency to orthogonal designs (completely randomized design or randomized complete block design) but only in a case when inter-block information was recovered. In the case of intra-block analysis incomplete blocks were always less efficient than complete ones.

4. Conclusion

Performed analyses of variance of the results of the experiment concerning seven characteristics of pea varieties showed, similarly to results from a similar trial conducted in 1999, that randomized complete blocks and completely randomized design attained for some characteristics the same level of efficiency as incomplete blocks or - for other characteristics - were slightly better.

Literature

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