

¹ J Stringer, ² B J Croft, ² S A Bhuiyan, ¹ E Deomano, ⁴ R Magarey, ³ M Cox and ⁵ X Xu

¹BSES Limited Indooroopilly, ²BSES Limited Woodford, ³BSES Limited Bundaberg, ⁴BSES Limited Tully, ⁵East Malling Research, Kent, United Kingdom

Introduction

- The method used by BSES for rating varieties for disease resistance since the 1970s was based on a regression equation for the relationship between the disease score of a set of standard varieties in the trial and the historical ratings of the standards on the 1-9 scale (Hutchinson method).
- This regression equation was then used to assign a rating to the test clones.
- Varieties are classified as ordinal categories .
 - Resistant (R), Intermediate (I) and Susceptible (S)
 - Where, R → 1-3 , I → 4-6, S → 7-9
- Representing ordinal categories of R, I and S by numbers on a 1-9 scale has lead to confusion:
 - It is assumes the categories are on a linear scale.
 - 10% increase in disease incidence per rating increment.
 - Numbers are used as a symbol to represent categories because they are easily used in calculations, eg. breeding values.
- In a recent review of the analysis of disease resistance trials, a new technique based on analysis with a linear mixed model was developed.

Method

- New statistical methods
 - Mixed model with "Clone" as fixed, "Replicate" as random.
 - Spatial variation accounted for analyse data using logit transformation, ie. $\text{Logit} = \log((\text{Infection}0.5)/(\text{total number of stools} - \text{infection}+0.5))$.
- Historical data set of standards
 - How many groups in historical data set using LSD?
 - How does the trial result compare to field reaction?
- Current trial
 - Do standards align with historical data set?
 - If yes, the trial is considered reliable.

Results and discussion

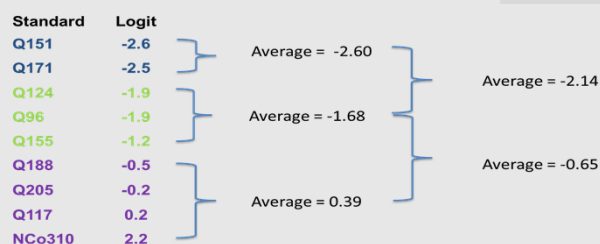
Table 1 - Smut trial analysis – an example.
Historical data for standards from Indonesia and Australia (35 trials)
6 LSD groupings correspond well with historical ratings.

Standard	Logit means	% infected plants	LSD group	Rating
Q151	-2.6	1.7	F	1
Q171	-2.4	4.6	F	1
Q96	-1.7	14.1	E	5
Q124	-1.7	15.1	E	5
Q155	-1.7	15.2	E	6
Q188	-0.6	36.1	D	7
NC0310	0.7	63.7	C	8
Q117	1.5	80.6	B	9
Q205	1.9	88.6	A	9

Table 2: Analysis of Standards in one smut trial.
5 LSD groups with overlap between some groups
Good correlation with R, I and S resistance groups

Standard	Logit means	Mean % infection	LSD group	Historical rating	Hutchinson method	New method
Q151	-2.6	0	E	1	1	2
Q171	-2.5	2.1	E	1	2	2
Q124	-1.9	8.9	DE	6	5	5
Q96	-1.9	8.3	DE	5	5	5
Q155	-1.2	22.5	CD	5	7	5
Q188	-0.5	37.2	BC	7	8	8
Q205	-0.2	44.4	BC	9	8	8
Q117	0.2	58.6	B	9	9	8
NC0310	2.2	91.3	A	8	9	8

Thresholds for Assigning Ratings to Test Clones:



Correlation between standards in SMB10-6 & historical data set = 0.8

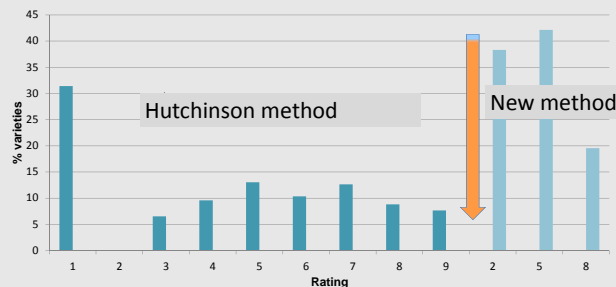


Figure 1: Comparison of Ratings in a smut trial. Hutchinson method would discard 25 more varieties than new method

Combined analysis – Q249 3 smut trials

Standard	Logit means	Mean % infection	LSD group	Hist. rating	No of reps	New method
Q151	-2.8259	5.59	E	1	18	2
Q171	-2.5897	6.98	E	1	19	2
Q249	-2.4909	7.65	E		8	2
Q155	-1.8456	13.64	D	5	15	5
Q96	-1.7279	15.09	D	5	17	5
Q124	-1.4168	19.52	D	6	6	5
Q188	-0.2166	44.61	C	7	6	7
NC0310	1.05	74.08	B	8	12	8
Q117	1.8532	86.45	A	9	12	9
Q205	2.0632	88.73	A	9	18	9

Conclusion

- Realistic estimate of how many rating groups can be defined statistically
- Does not assume a linear relationship
- Recognises and accounts for the variability within and between the rating groups
- Rates clones based on which standard they are statistically closest to
- Correlation with historical data set provides an estimate of reliability of trial
- More conservative than Hutchinson method
- Can combine data across trials which will give best possible estimate of resistance of clones