Development of a new method of statistical analysis for disease screening trials

BSES Limited: J Stringer, B J Croft, S A Bhuiyan, E Deomano, R Magarey, M Cox

EMR, Kent, UK: X Xu

Australian Government
Sugar Research and Development Corporation

Background

- The method used by BSES for rating varieties for disease resistance was based on a regression equation for the relationship between the disease score of a set standard varieties in the trial and 1-9 ratings of standards (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
    - e.g. 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.

Objectives

Method

1) New statistical methods

- Mixed model with "Clone" as fixed, "Replicate" as random
- Spatial variation accounted for
- Analyse data using logit transformation
- i.e. Logit = log((Infection0.5)/(total number of stools – infection+0.5))

2) Historical data set of standards

3) Current trial

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
NCo310	0.7	63.7	C	8
Q117	1.5	80.6	B	9
Q205	1.9	88.6	A	9

BSES
Sugarcane for the future

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
NCo310	2.2	91.3	A	8	9	8

Thresholds for Assigning Ratings to Test Clones: SMB10-6

Standard	Logit
Q151	-2.6
Q171	-2.5
Q124	-1.9
Q96	-1.9
Q155	-1.2
Q188	-0.5
Q205	-0.2
Q117	0.2
NCo310	2.2

Average = -2.60

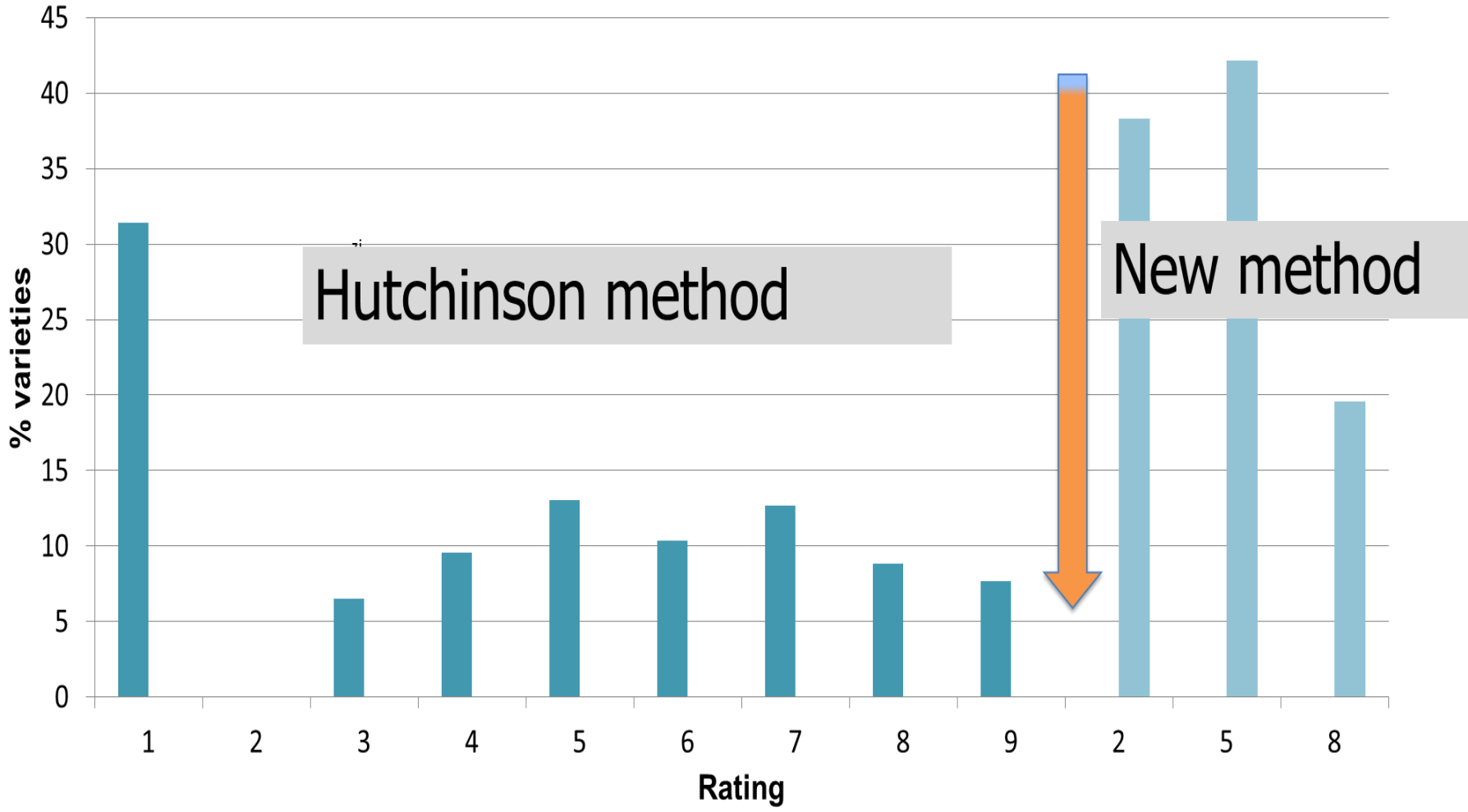
Average = -1.68

Average = 0.39

Average = -2.14

Average = -0.65

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


45
40
35
30
25
20
15
10
5
0
% varieties
Hutchinson method
New method
1
2
3
4
5
6
7
8
9
2
5
8
Rating

In summary

- 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
- More conservative than Hutchinson method
- Can combine data across trials which will give best possible estimate of resistance of clones