

Uniformity trials and the reliability of blackleg resistance ratings

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ABSTRACT

In Australia, one use of blackleg nurseries is to develop blackleg ratings. All varieties in S2, S3 and S4 yield trials are included and nurseries are conducted at sites in four states. Percentage survival data (derived from the difference between two plant counts, one soon after emergence and the second near maturity) from these sites is analysed using an across-sites technique. From this analysis, ratings are calculated and published by the Canola Association of Australia. Two of the major assumptions underlying these ratings are that, firstly, plant losses between the two counts are all due to blackleg, and secondly, inoculum levels and subsequent infection across a nursery are uniform. This study aimed to quantify the level of variation across nurseries at two sites. Uniformity trials were sown at Wagga Wagga and Struan in 2001. Two varieties, with different sources of resistance, were sown, Surpass 400 (with the *sylvestris* gene) and Emblem. The uniformity trials demonstrated a high proportion of local error in this type of data. Thus, ratings based on one site are unlikely to be very reliable. The current system of analysing multiple sites together provides extra replication (since experience has shown GxE to be reasonably small) and increases the precision of estimating ratings.

Key words: *Brassica napus* – *Leptosphaeria maculans* - blackleg resistance – variety ratings

INTRODUCTION

Blackleg disease, caused by *Leptosphaeria maculans* (Desm.) Ces. & de Not. (*Phoma lingam* (Tode ex Schw.) is the most important disease of canola, *Brassica napus*, crops in Australia. Selection for resistance to the basal stem canker phase of the disease has been a priority for breeding programs since they began in the early 1970s. Many varieties, with a range of resistance, have been released. To assist farmers in their decision making, resistance ratings for all commercially available varieties are published by the Canola Association of Australia.

Blackleg nurseries are used to develop these ratings. All varieties and breeding lines in S2, S3 and S4 trials (different stages of multi-locational trials) are included in nurseries grown at sites in four states. In any one year, there can be up to twelve locations with both public and private organisations involved. Percentage survival data (derived from the difference between plant counts soon after emergence and counts near maturity) from these sites is analysed using an across-sites, across-years technique similar to that used for yield by Smith *et al.* (1998). From this analysis, ratings are calculated. Two of the major assumptions underlying these ratings are, firstly, that plant losses between when the two counts are taken are all due to blackleg, and secondly, that inoculum levels and subsequent infection across a nursery are uniform. If these assumptions are wholly, or partly, unjustified, then the reliability of the blackleg ratings can be questioned. This study aimed to quantify the level of variation across two nurseries, but did not examine the sources of this variation.

MATERIALS AND METHODS

Two uniformity trials were sown in blackleg nurseries in 2001, one at Wagga Wagga in New South Wales, the other at Struan in South Australia. The trial at Wagga Wagga consisted of 10 ranges each with 42 rows while the trial at Struan had 4 ranges each with 41 rows. Two varieties were sown, Surpass 400 and Emblem. On a 1-9 scale, with 9 being the most resistant, these varieties had resistance ratings of 9 and 7, respectively. They also differ in their source of blackleg resistance with Surpass 400 having the *sylvestris* gene and Emblem, although uncharacterised, probably has a polygenic base. At Wagga Wagga, Surpass 400 was sown in ranges 1 to 5 and Emblem in ranges 6 to 10. At Struan, Emblem was sown in rows 1 to 20 and Surpass 400 in rows 22 to 41.

Plant counts for each row were taken after emergence and again close to maturity. For this analysis, the two plant counts were considered as two variates. The variates were then analysed in a "bivariate" spatial analysis where correlation was allowed for between the two plant counts on any row. Additionally, the spatial variation in both variates was modelled using the method outlined in Gilmour, Cullis and Verbyla (1997). All analyses were conducted on the log transformed data using the SAMM software package in S-Plus. An adjusted post disease count was obtained by considering the

“conditional” distribution of the post-disease count given the pre-disease count. This quantity was termed the survival index.

RESULTS

The results of the spatial analysis are summarised in Table 1. The spatial correlation parameters indicate that there is only weak correlation between rows in the nursery. The column labelled conditional variance is the variance of the survival index. The variance for Emblem is higher for both sites. The low spatial correlation implies that the major source of variation is not due to systematic field trend in the level of blackleg.

Table 1. Summary of spatial analysis (E = Emblem, S = Surpass 400)

| Trial | Variety | Range ρ | Row ρ | σ_1 | σ_2 | ρ | Conditional variance | Mean |
|--------|---------|--------------|------------|------------|------------|--------|----------------------|------|
| Wagga | E | .130 | .261 | .114 | .164 | .838 | .04880 | 56 |
| Wagga | S | .237 | .142 | .121 | .132 | .894 | .02648 | 73 |
| Struan | E | .054 | .105 | .066 | .097 | .754 | .04172 | 68 |
| Struan | S | .182 | .209 | .032 | .039 | .873 | .00925 | 97 |

Figures 1 to 4 present trellis plots of the survival index for each data-set. These reinforce the results of the spatial analysis. There is some evidence of spatial variation but this is swamped by local errors.

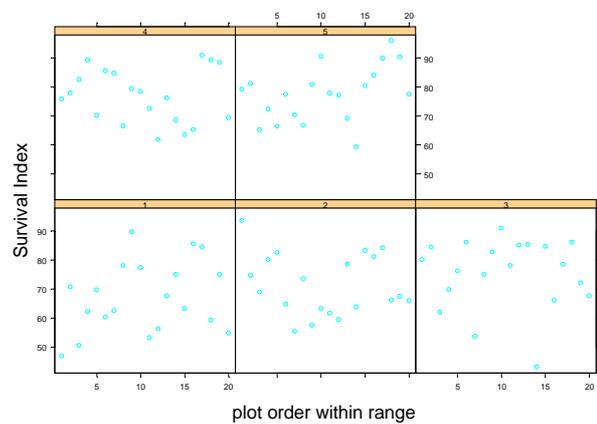
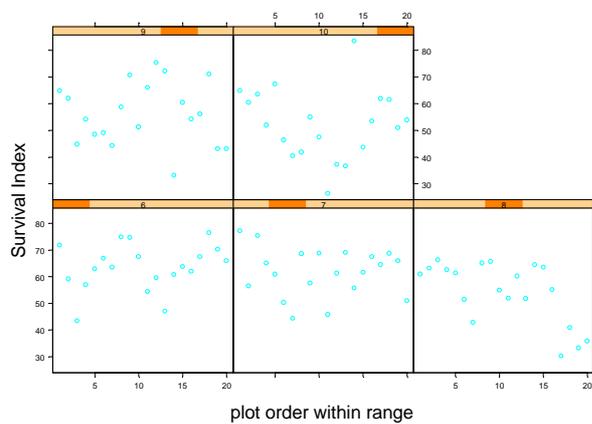


Figure 1. Wagga Wagga – Emblem data set.

Figure 2. Wagga Wagga – Surpass 400 data set.

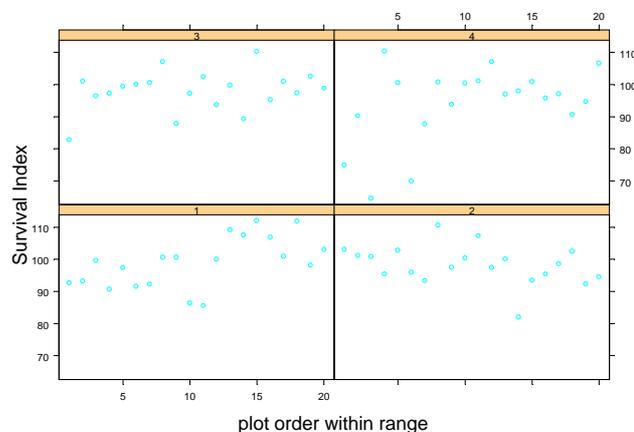


Figure 3. Struan – Emblem data set.

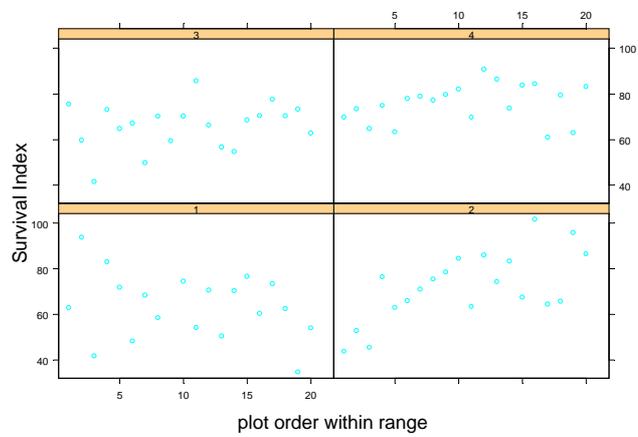


Figure 4. Struan – Surpass 400 data set.

DISCUSSION

These uniformity trials have demonstrated a high proportion of local error in this type of data. Thus, ratings based on one site are unlikely to be very reliable. The current system of analysing multiple sites together provides extra replication (since experience has shown GxE to be reasonably small) and increases the precision of estimating ratings, but by how much has yet to be quantified. Additional trials were conducted in nurseries at Wagga Wagga and Struan in 2001 and 2002 but this data has not yet been included in the analysis.

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