A national system for comparative rating of blackleg resistance in *Brassica napus* L. cultivars in Australia

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Abstract

Blackleg is the major disease of canola in Australia. Consequently, farmers choose canola cultivars based on their level of blackleg resistance. During the 1990s, companies published their own blackleg ratings leading to confusion amongst farmers. To overcome this situation, a national system for comparative rating of blackleg resistance has been established in Australia for the past 6 years. The system is coordinated by the Canola Association of Australia. Protocols for testing and minimum standards that have to be met for the inclusion of data have been devised. Data can be submitted by public and private researchers provided the blackleg nurseries have been quality assured by independent observers. Data from all nurseries are combined for analysis using all relevant nurseries from three years of testing prior to and including the current year. Minimum disease severity standards are enforced where the survival of a nominated susceptible control cultivar must be less than 30% in conventional and triazine tolerant trials and 40% for Clearfield trials (more susceptible Clearfield cultivars are not available). The analysis accommodates error variance heterogeneity between trials and spatial variation within trials, thereby increasing the accuracy and precision of cultivar estimates. The analysed results are arithmetically converted to a 1-9 scale with 9 representing the line/cultivar with the highest survival and 1 representing the lowest survival. Cultivars with less than 6 site years over two calendar years are given a provisional rating. Ratings are managed and presented to farmers by the Canola Association of Australia. Correlations between sites and years have been very high indicating that the national ratings are a very robust system.

Key words: Canola, *Brassica napus*, blackleg, rating system, Australia

Introduction

Blackleg disease caused by the fungus, *Leptosphaeria maculans* (Desm.) Ces. et de Not. [anamorph = *Phoma lingam* (Tode:Fr.) Desm] is the most serious pathogen of canola in Australia and can cause major yield losses. Blackleg resistance has been the major breeding aim for all Australian breeding programs with significant progress made over many years.

Blackleg is controlled in Australia through genetic blackleg resistance in released cultivars, separating the current crop from the residue of previous canola crops and the use of a seedling protective fungicide. One of the key selection criteria that farmers therefore use when deciding which canola cultivar to purchase is the cultivar's blackleg resistance rating. In Australia during the 1990s, each canola breeding program released its own independent blackleg rating. This system caused confusion and distrust amongst farmers. In response, all breeding programs unanimously decided to create an independent national blackleg rating system. For the system to be truly independent it was important that it was based on objective data (no visual assessments) and that the rules for data inclusion were documented and adhered to. The system also allows any organisation to submit data as long as they meet the specified criteria. The system has now been in place for 6 years and has been widely adopted by farmers and farm advisors.

Material and Methods

Nurseries

The disease nurseries are grown on canola stubble from the previous year. Single rows of 100-200 untreated seeds are sown in at least 3 replicates in balanced trial designs. A list of susceptible through to resistant check cultivars is provided to be included in all trials to enable across site data analyses. After germination the number of plants to emerge is counted. Rows that have less than 20 plants at emergence are excluded from the analysis. All normal agronomic treatments are applied to ensure that trials are grown under optimum conditions. All trials are checked by an appropriately qualified person from another organisation to the trial cooperator to ensure that no factor other than blackleg can compromise the data. At maturity the number of surviving plants is counted to determine the survival percentage. Protocols used are summarised in Table 1.

Statistical analysis

Data from all nurseries are combined for analysis using all relevant nurseries from three years of testing prior to and including the current year. For a site to be included in the analysis, the survival of a nominated susceptible control cultivar must be less than 30% in conventional and triazine tolerant trials and 40% for Clearfield trials. The variable for analysis was the percentage of plants that survived to maturity. A transformation of this percentage was necessary in order to satisfy the statistical assumption of constant within-trial error variance. The unbalanced nature of the data, that is, not all cultivars in all

trials, necessitates the use of mixed model techniques for analysis (Smith et al., 2001). The analysis accommodates error variance heterogeneity between trials and spatial variation within trials, thereby increasing the accuracy and precision of cultivar estimates. The analysed results are arithmetically converted to a 1-9 scale with 9 representing the line/cultivar with the highest survival and 1 representing the lowest survival. Cultivars with less than 6 site years over two calendar years are given a provisional rating.

Table 1. Blackleg nursery standards for data inclusion

Blackleg severity	For conventional and TT trials a maximum 30% survival of susceptible control Karoo. For Clearfield trials a maximum 40% survival of susceptible Clearfield cultivar 44C73. No Clearfield cultivar with equivalent blackleg resistance to Karoo is available. Note: if nurseries are not treated with a triazine or Clearfield herbicide include both Karoo and 44C73.
Controls	Determined in April each year.
Seed treatments	Official CAA ratings will only be determined on untreated seed.
Stubble type	Must indicate the cultivars of the stubble that the nursery is sown into.
Trial design	Trial design must be balanced.
Minimum plant number	20 per row at emergence.
Replication	3 replicates minimum sown (2 can be submitted if a replicate fails).
Emergence count	After emergence of all seedlings (open cotyledon stage) but before plant death. If plant death begins before this time two counts can be undertaken; one during emergence and one after emergence is completed.
Maturity count	The final count should be performed at plant maturity (windrowing stage).

Results

For the analysis undertaken for the 2006 blackleg ratings (using data from 2003-2005) 63 experiments and 42 sites were included. The majority of sites were highly correlated (Fig. 1). In the biplot, the cosine of the angle between 2 site vectors equals the correlation. e.g 60degrees is a correlation of 0.5. The square root of the length of the site vector equals the amount of variation explained by the model. Sites 4, 16 and 26 were outliers. Of these three sites, 4 and 16 had a low percentage of plant death in all but the most susceptible checks and so did not differentiate between lines other than the very susceptible lines. Site 26, contrary to most other sites, had very high plant mortality for both polygenic and *sylvestris* derived germplasm.

For the commercial cultivars that were available to farmers in 2006, blackleg resistance ratings ranged from 4.0 (regarded as moderately susceptible) up to 8.0 (highly resistant), with many cultivars having ratings of at least 7.0 (20 out of 42 cultivars).

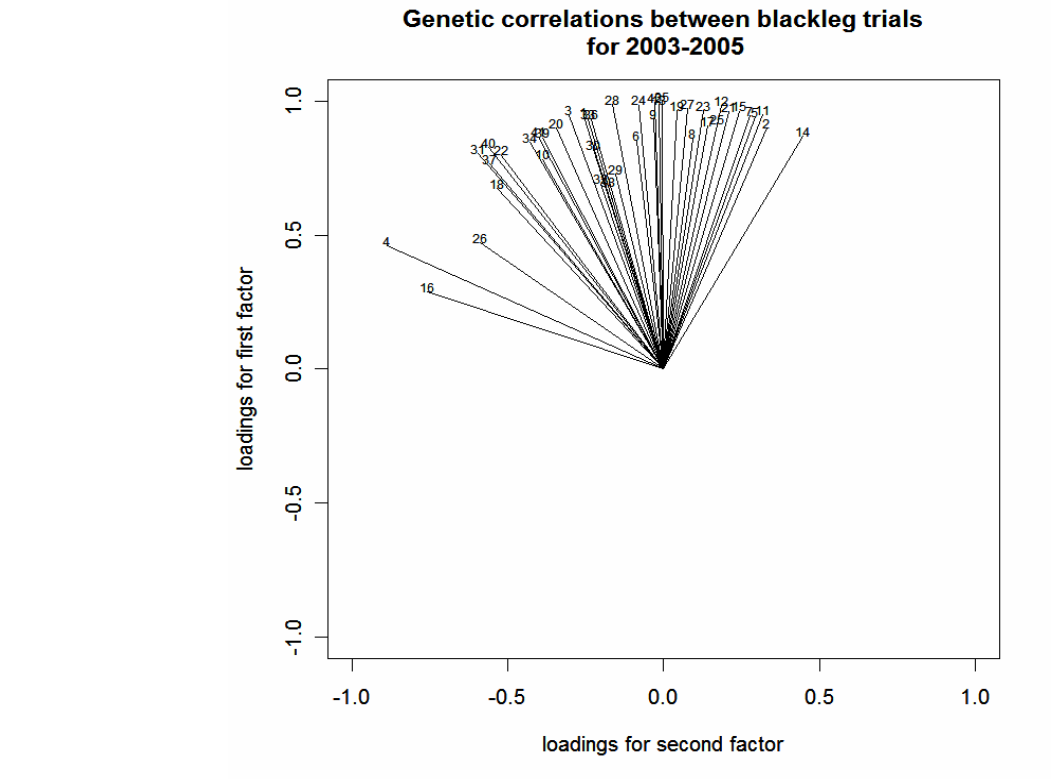

Fig. 1. Genetic correlations between blackleg nurseries sown in 2003-2005

Discussion

The majority of sites showed very high genetic correlations, often above 0.8. However a few sites were poorly correlated

with others. This was likely due to poor differentiation of resistance due to lower levels of blackleg being present or mixtures of polygenic and *sylvestris* attacking blackleg populations.

Analysis of individual sites in uniformity trials has shown a high proportion of local error in blackleg survival data. However, the use of multiple sites provides additional replication and increases the precision of estimating ratings as experience has shown that GXE is reasonably small (Wratten et al., 2003).

The use of a national database produced under standard protocols has allowed information to be derived that also can demonstrate the deterioration in blackleg resistance of cultivars over years.

In 2006, 42 cultivars were available to farmers. Of these, 20 had blackleg resistance ratings of 7 or above. Potter et al., 2003 showed that there was a good relationship between blackleg resistance rating and yield loss, and recommended that under severe blackleg pressure farmers should grow cultivars with a blackleg resistance rating of 7 or above. Experience has shown that lower levels of blackleg resistance are acceptable when canola was grown in lower rainfall areas where blackleg is not yet a major yield limiting factor. In these areas, a blackleg resistance rating of greater than 4 is accepted by the industry as being adequate at present. If more canola is grown in these areas, resulting in higher levels of stubble and therefore the likelihood of more severe blackleg, then higher resistance ratings may be recommended.

The blackleg resistance ratings are published annually by the Canola Association of Australia (canolaaustralia.com) and are used by all breeding and seed marketing companies in describing their cultivars. This has enabled uniform information to be presented to farmers so that they can make decisions based on good information and reduces the confusion that used to occur when the same cultivar was described with different ratings by different companies.

Conclusions

The national blackleg resistance rating system in Australia has provided a source of consistent information based on blackleg nurseries conducted throughout the canola growing areas. The analysis showed that the majority of sites were very highly correlated. Farmers now base their decisions on cultivar choice on the blackleg ratings because this disease has had a major impact on canola yield in Australia.

References

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