EFFICIENT SCREENING FOR MID-SEASON COLD DAMAGE IN RICE

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Abstract

Aseries of 3 experiments was conducted in controlled temperature rooms at Yanco Agricultural Institute to screen current and advanced breeding lines for mid-season cold tolerance. These studies showed significant genetic variation for cold tolerance among the 8 improved and introduced lines. Estimates of precision of these experiments demonstrated that 3 experiments with 2 replicates are required to maximise precision in a resource efficient manner.

Key words: Rice, temperate, low-temperature, microspore, pollen.

Rice yields in the Riverina region of NSW are highly variable and depend on favourable temperatures during the reproductive stage of development. Low night temperatures (less than 15^{o}C) during pollen formation can cause massive pollen sterility, lack of fertilisation and very low yields. The development of low temperature tolerant rice is a major focus of the rice breeding program based at Yanco Agricultural Institute.

Materials and methods

Seven rice genotypes were exposed to high and low temperature regimes during the critical stage of pollen development. Two of the varieties (Calrose and M7) were introduced from California, 4 were Australian pro- duced lines with Calrose and M7 as parents (Amaroo, Bogan, YRM5 and Echuca), and the final genotype was Pelde, an Australian long grain variety.

Rice plants were grown up to panicle initiation in non-limiting temperatures (26 day/30^{o}C night). Five days after panicle initiation, plants were moved into one of 2 controlled temperature rooms. The rooms were maintained at a day/night temperature of 28/20^{o}C and 24/15^{o}C, respectively. After flowering, the plants were moved back to the heated glasshouse until physiological maturity. At maturity, percent filled grain was determin-ed for all pots as the measure of cold damage.

Results and discussion

There was significant genetic variation for percent filled grain in both the high (28/20^{o}C) and the low (24/15^{o}C) temperature treatments. There was a smaller range in fertility across genotypes and experiments in the high compared to the low temperature treatment.

An analysis of the sums of squares of the analysis of variance was used to estimate variation components within each of the 2 temperature environments. Est-imates of each variance component for both treatments are presented in Table 1. Negative estimates of variance due to reps within experiments for both temperatures were assumed to be 0.

There was greater genetic variation in the low temperature treatment compared to the high temperature treatment. The estimate of DELTA s 2 G*E also differed according to the temperature of the treatment. In the low temperature treatment,? s^2_{G*E} was 21% of s 2G. In the high temperature,? DELTA s2G*E was 900% the estimate of s2G due to very low levels of s2G.

Assuming that the experiments are a random sample of experiments screening for cold tolerance using the facilities at Yanco Agricultural Institute, and that the lines are an adequate sample of likely test lines,? precision (P) of estimating genetic variance in further experiments can be estimated. P is defined by

equation (1) where s2G is the genetic variation, s2G*E is the variation due to the genotype by experiment interaction, *ne* is the number of experiments and *nr* is the number of replicates.

By substituting a range of experiment and replicate numbers into Equation 1, precision of estimating cold tolerance was estimated. Fig. 1 shows the dramatic improvement in precision with the use of 2 or more experiments compared to using 1 experiment at both temperatures.

Conclusions

The most efficient method for screening rice varieties for low temperature tolerance would be using 3 experiments, 2 replicates and 2 temperatures for each variety. The use of 2 replicates would allow for a larger number of genotypes to be tested with the same glasshouse resources in each experiment.