



IMPROVING WHEAT BY COMPOSITE CROSSES BASED ON 'CORNERSTONE'
NUCLEAR MALE STERILITY

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by

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SUMMARY

The utilization of composite crosses in wheat breeding was investigated by using a composite cross based upon 'Cornerstone' male-sterility. The composite was established by crossing seven Australian wheats to a homozygous male-sterile 'Cornerstone' stock. It was propagated through seed harvested from steriles only in the F_2 and subsequent generations.

Two composite populations were grown concurrently. A 'Random' series was propagated through seed from randomly chosen steriles while a 'Selected' series was propagated through the progenies of steriles less than 100 cm high selected for long heads and high spikelet number. In each generation 10 seeds from each 100 chosen steriles were used to establish the next composite population.

Height, number of tillers, and the headlength, spikelet number, grain number and yield of the longest head of each individual plant were measured in the first three generations of each series. Their fertility/sterility classification was also recorded. The ratio of fertiles to steriles departed from expected ratios and was probably caused by differential wind-borne pollen transmission. Significant differences in the average expression of some characters between fertiles and steriles occurred in the first composite generation, but the differences decreased in subsequent generations. The differences may have been caused by genes initially linked to the male-sterile (*Ms 1C*) locus. The correlations between characters changed significantly over three composite generations. The trends in correlations suggested that competition between fertile pollinators was intensifying the association of characters which favoured pollinator effectiveness such as height and high numbers of florets per plant.

The yields of bulked progenies of fertiles from the first seven generations of each composite series did not have any significant trend and were significantly less than the best parents and commercial check varieties. Therefore visual selection of male-sterile parents in each generation was ineffective. Selection of S_0 fertile plants for

The methods used for

morphological characters and yield components to increase yield ~~was~~ either ineffective or of ~~so~~ little value that ~~it would be an inefficient selection procedure.~~

Comparison of the yields of some S_0 -derived S_2 lines with parents and S_1 and S_2 bulks demonstrated that S_2 progeny testing of individual S_0 fertile plants would identify high-yielding S_0 -derived families. This would probably be an effective selection procedure. The best S_0 -derived families could be reselected in later near-homozygous generations or used to reconstitute composite populations in a recurrent procedure.

After three cycles of outcrossing in the composite cross, 90 $F_3(S_2)$ -derived F_5 families were derived from the Random and Selected series and the distributions of their yields were compared at three sites with a Control population of F_5 families derived directly from the seven F_1 s which were used to construct the composite populations. The means of the distributions of the populations did not generally differ greatly at each site. The most obvious aspect of the results was the presence of high-yielding 'tails' in the Random and Selected distributions which contained lines equal to or significantly exceeding the highest yielding parents and commercial checks. Sister-lines occurred ~~so~~ frequently in these 'tails' at each site that an analysis of probabilities suggested that intermating and recombination within the two series of composite crosses had generated S_0 genotypes from which high-yielding S_2 -derived families had descended. None occurred in the 'Control' sample of equal size.

Samples from the extremes of the distributions of F_5 lines were compared in the next year as F_6 lines. The high-yielding 'tails' and strong correlation of sister lines were again evident, especially in the Selected series.

A small sample of the highest yielding lines were compared with some of the highest yielding parents and commercial checks for two ~~more~~ seasons. Some lines were consistently higher yielding, but unsuitable for commercial production in Australia because of red grain colour and unacceptable associations of quality characteristics. Strong correlations of quality characteristics also occurred within sets of F_3 -derived sister lines.

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It was concluded from the experimental programme that composites based on 'Cornerstone' nuclear male-sterility in which outcrossing is enforced for a few generations would be a useful component of a wheat improvement programme. They would generate useful variation which could be identified if the composite were partitioned into families derived from S_0 individuals or early-generation segregants.