SELECTION FOR YIELD IN EARLY GENERATIONS USING THE NEAREST-NEIGHBOUR (NN) DESIGN

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Yield is an important selection criterion in most breeding programmes. However, success in improving yielding ability can be difficult. Apart from the obvious genetic reasons, lack of response to selection can result from an inability to differentiate between tested lines and reliably recognize high yielding genotypes.

Field trials involving large numbers of genotypes almost invariably possess high variability. In most instances this is a reflection of soil heterogeneity. In an attempt to overcome this problem plant breeders have improved the efficiency of trial designs by developing and using incomplete block designs such as lattices and lattice squares. However, this methodology is fully efficient only if fertility effects are constant over each block. Since soil fertility and other such factors vary continuously over the field, such constancy is typically not present (Wilkinson *et al.*, 1983a).

In recent years, a statistical technique known as the nearest-neighbour (NN) design has been developed. For those interested in the theory behind the design and analysis of data, Wilkinson *et al.* (1983b) and Gleeson and Cullis (1987) are recommended. In brief, nearest-neighbour analysis involves a continuous process of detrending data by adjusting the yield of each individual plot using the yields of the two nearest neighbours. Unfortunately, since the design and analysis is more complicated than that for incomplete block designs, a computer and appropriate programmes are required for a breeder to use this technique.

We began using the nearest-neighbour design for our advanced trials. In these, varieties are evaluated at six sites, with four replicates per trial. Plot size is 20 m x 1.6 m, ie. 32 m^2. The number of varieties tested is usually in the range of 20-25. Significant reductions in error mean squares and consequently standard errors of differences resulted from using the NN analysis, in comparison with a randomised complete block design.

Once we had made considerable progress in combining quality ie. low erucic acid and low total glucosinolate levels, with resistance to the disease blackleg (*Leptosphaeria maculans*), our attention turned to increasing yield. The nearest-neighbour design seemed particularly appropriate for testing single plant *Brassica napus* selections at an early stage (F_3 and F_4) in the breeding programme. The main reasons for this were that sufficient seed was available to allow replication and the NN design was not restrictive as far as the number of entries in a trial was concerned. It suited us to test 80 entries in each trial, with two replicates per trial and a plot size of 7 m x 0.75 m.

Nearest-neighbour analysis of the yield data from such preliminary trials has enabled us to identify several lines significantly higher yielding than control varieties. Two such lines, BLN 270 and BLN 273, have now been extensively tested throughout rapeseed growing areas in Australia and are currently being registered as new cultivars. A third line, BLN 312, shows further improvement over BLN 270 and BLN 273. In Table 1, comparative yields of these lines over two years with control varieties (ie. those grown commercially) are listed. The high yielding ability has been achieved in combination with Canola quality (mean of approximately 8 micromoles) and good resistance to the basal stem canker phase of the disease blackleg.

Table 1 : Comparison of yields from New South Wales' core trials and Interstate trials.

Line	Yield (kg/ha)			
	1985		1986	
	New South Wales	Interstate	New South Wales	Interstate
BLN 312	-	-	2606	2797
BLN 270	2421	2288	2431	2560
BLN 273	2425	2221	2457	2457
Wesbrook	2117	1997	1973	2134
Marnoo	2307	-	1888	2118
Tatyoon	2240	1992	2271	2247

The advantage in yield of the BLN lines is quite obvious. An interesting feature is their ability to yield over widely differing environments indicating little genotype x environment interaction. This is despite being selected, initially, at one site only.

To illustrate some results of the NN analysis, a few examples from one of our preliminary trials in 1986 are shown in Table 2. Because of limited resources, we have not, at this stage, compared NN analysis of the preliminary yield trials with alternative methods of analysis. Experience with comparable stage cereal trials has indicated the superiority of the NN analysis (Cullis B.R., pers. comm.).

Table 2 : Effect of nearest-neighbour analysis on yield and rankings - some examples

Line	Yield (g/plot)		Change	Ranking	
	Before Analysis	After Analysis	(%)	Before Analysis	After Analysis
17-12-1	2640	2781	+5.3	1	1
17-12-4	2347	2271	-3.3	3	10
18-19-3	2300	2290	-0.4	7	7
18-14-2	2272	2160	-4.9	10	19
17-68-4	2210	2306	+4.3	17	5
BLN 273	2230	2179	-2.3	13	17
Wesbrook	1484	1468	-1.1	70	67
Tatyoon	1368	1357	-0.8	73	74

To conclude, Figure 1 illustrates how fertility effects are not constant across blocks with data from one row of 20 plots from a 1986 preliminary trial. If you imagine four blocks of five plots, you will see how such blocking cannot cope efficiently with this trend. The data is not particularly variable as the coefficient of variation for the trial was 10.2%. It is the ability of the NN design and subsequent analysis to accurately predict varietal means from such data that demonstrates its superiority over other techniques.

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References

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Figure 1: Variation in trend + error across a row of 20 plots