

## Possible Linkage of Falling Number Value with Gliadin Proteins in Wheats with Genes for Improved Sprouting Resistance

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Sprouting resistance (i.e., high falling number [FN] value) is a major objective in Canadian wheat breeding programs. The superior breadmaking quality of Canadian wheats can be preserved by eliminating the detrimental changes to the wheat kernel produced by preharvest sprouting. However, the multigenic inheritance of sprouting resistance makes it a difficult characteristic to incorporate into new cultivars (Dyck et al 1986). Current breeding strategies involve selection of sprouting-resistant lines by using labor-intensive assessment of grain subjected to rain simulator or natural rain treatment by the FN test or by visual scoring. Alternative selection techniques, such as electrophoretic analysis, which require less time and grain (e.g., half a kernel per test) would be desirable. In our laboratory, 1,000 breeders' lines can be analyzed electrophoretically in approximately 32 work hours.

The Canadian wheat (*Triticum aestivum* L.) experimental line RL4137 has been an excellent source of preharvest sprouting resistance. This trait was transferred into the cultivar Neepawa through a series of five backcrosses to produce the cultivar Columbus (Campbell and Czarnecki 1981). During the analysis of a number of Canadian cultivars for gliadin proteins by polyacrylamide gel electrophoresis (PAGE), it was observed that the Columbus electrophoregram was identical to that of RL4137 but not to that of Neepawa, the recurrent parent (Fig. 1). Four gliadin bands (A, B, C, D of Fig. 1) were present in Columbus and RL4137 but not in Neepawa. Because these bands appeared to be transferred, along with improved FN value, into the cultivar Columbus, we speculated that the genes conferring these traits may be linked. Such an association would make PAGE a useful method for selection for sprouting resistance in segregating populations of a breeding program. Accordingly random lines of RL4137/Neepawa developed by Dyck et al (1986) were used to test for the association.

Gliadin electrophoregrams for each of the 93 random lines of RL4137/Neepawa were determined as previously described (Dyck et al 1987). Four distinct protein banding patterns were observed: identical to RL4137 (type 1), identical to Neepawa (type 2), and two different recombinant types, one with the low-mobility bands A and B (type 4), the other with high-mobility bands C and D (type 3) (Fig. 1). The distribution of 22 type 1, 27 type 2, 21 type 3, and 23 type 4 lines gave a good fit to a 1:1:1:1 ratio with a chi-square value of 0.89 (3 degrees of freedom,  $0.80 < P < 0.90$ ), indicating that the low- and high-mobility band pairs are each controlled by independently inherited single genes.

The mean FN values of the random lines of RL4137/Neepawa have been reported (Dyck et al 1986). The heritability estimate for the FN values was 0.78. Because the trimodal frequency distribution had low points at FN values of 280 and 380, the random lines were grouped into three classes: 1) lines with a mean FN value less than 280; 2) lines with FN values between 280 and 380; and 3) lines with FN values greater than 380. The chi-square value of 7.89 (6 degrees of freedom,  $0.20 < P < 0.30$ ) from the  $3 \times 4$  contingency table (Table I) indicates that there

is insufficient evidence to reject the hypothesis that the mean FN values are independent of the four types of gliadin patterns. However, this test examines both of the gliadin genes controlling the low- and high-mobility band pairs evident in RL4137 when only one of the two genes may be linked to the dormancy genes of RL4137.

To test for the association of the low-mobility pair of gliadin bands with FN values, lines with pattern types 1 and 4 and types 2 and 3 were grouped for analysis; the chi-square value of 0.32 was obtained. This is nonsignificant (2 degrees of freedom,  $0.80 < P < 0.90$ ). However, the association of FN value and the high-mobility pair of bands was nearly significant at the 5% level; when band types 1 and 3 and types 2 and 4 were combined,

TABLE I  
Frequency Distribution of Gliadin Electrophoregram Types and Mean Falling Number Values of Random Lines of RL4137/Neepawa Wheat

Falling Number Value Range	Gliadin Electrophoregram Type				Total
	1	2	3	4	
<280	5	10	5	11	31
280-380	8	10	9	10	37
>380	9	7	7	2	25
Total	22	27	21	23	93

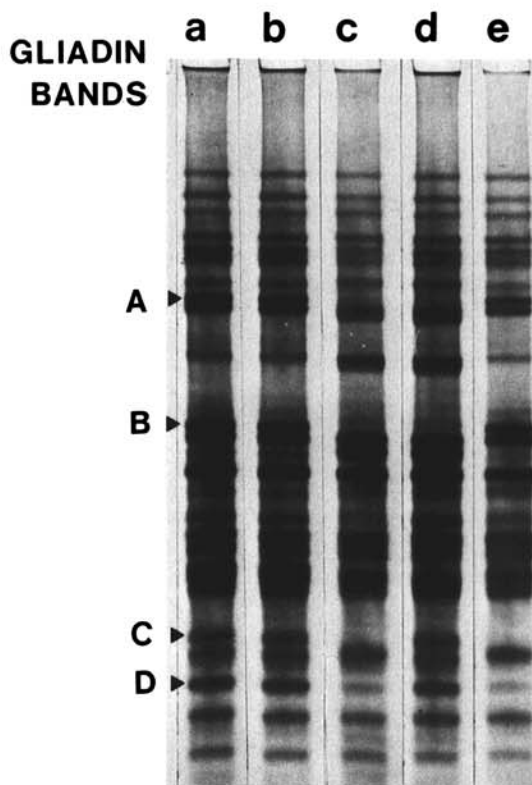


Fig. 1. Gliadin polyacrylamide gel electrophoretic patterns in sodium lactate at pH 3.1: a, RL4137 (pattern type 1); b, cv. Columbus (type 1); c, cv. Neepawa (type 2); d, type 3 (high-mobility bands C and D); and e, type 4 (low mobility bands A and B).

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the chi-square value was 5.61 (2 degrees of freedom,  $P = 0.06$ ). Accordingly a possible linkage between FN value and gliadin bands C and D is indicated. However, the association is not strong enough to be of practical value in selecting for sprouting resistance in wheat breeding programs based on RL4137 as the source of the resistance. Nevertheless, prescreening of early generation lines for these bands followed by determination of FN values of the selected lines would increase the relative selection efficiency of lines with improved sprouting resistance. In the cross of RL4137/Neepawa, selecting lines with gliadin bands C and D would increase the proportion of lines with FN values in excess of 380 to 37% (16 of 43 lines) of the electrophoretically preselected group from 27% (25 of 93 lines) of the total population of random

lines. Whether or not the apparent linkage of some gliadin bands to sprouting resistance may be a useful marker in wheat breeding programs remains to be investigated with other crosses.

#### LITERATURE CITED

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