# Effect of 1B/1R Chromosome Translocation on Milling and Quality Characteristics of Bread Wheats

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## ABSTRACT

Backcross derivatives of three commercial Australian bread wheat varieties carrying the 1B/1R translocation were compared with their recurrent parents for a range of milling and quality characteristics. The 1B/1R translocation generally had no major deleterious effects on 1,000-grain weight, test weight, grain protein, flour protein, grain hardness, milling quality (flour yield and color) or farinograph water absorption. In the hard wheats the 1B/1R translocation did substantially and consistently reduce SDS-sedimentation volume and dough development time. There was also a tendency towards reduced extensigraph resistance and extensibility. However, for the latter characteristics the best 1B/1R derivatives were similar to the recurrent parents. In sharp contrast, in the soft wheat derivatives there was no evidence that the 1B/1R translocation significantly reduced SDS-sedimentation volume, dough-development time, or extensigraph resistance. In this case, however, dough extensibility was consistently reduced in the 1B/1R derivatives. The reasons for this contrast between the effects of the 1B/1R on hard and soft wheats is unknown and deserves further study.


Modern bread wheat contains 21 chromosome pairs arranged in three groups (A, B, and D genomes) of seven (i.e., 1A, 2A . . . 7A; 1B, 2B . . . 7B; 1D, 2D . . . 7D) that can be traced back to the ancestors of modern wheat. Each chromosome consists of two arms, which for some chromosomes are readily distinguishable and differ in length. Cereal rye, by comparison, contains only one group (R genome) of seven chromosomes (i.e. 1R, 2R . . . 7R). In 1B/1R substitution lines, chromosome 1B of wheat has been replaced by 1R of cereal rye, while in the 1B/1R translocation stocks, the short arm of 1B has been replaced by the short arm of 1R.

The 1B/1R chromosome translocation is being widely used in wheat breeding programs around the world. For example in the German Democratic Republic, 30% of recent breeding lines are reported to contain the 1B/1R translocation (Mettin and Bluthner 1984), whereas approximately 45% of advanced lines in the CIMMYT program carry this chromosome (Anonymous 1985). The reasons are twofold. First, the short arm of the 1R chromosome segment derived from Petkus rye carries genes for resistance to four major wheat diseases: powdery mildew, stripe rust, leaf rust, and stem rust (Mettin et al 1973, Zeller 1973). Second, several wheats carrying this translocation chromosome have performed exceptionally well in environments to which they are adapted.

In contrast to its substantial and beneficial agronomic effects, the 1B/1R translocation appears to have serious detrimental effects on hard wheat quality. In particular, doughs derived from such wheats often develop marked stickiness with high-speed mixing and are associated with reduced dough strength and intolerance to overmixing. Studies in Australia and elsewhere indicate that translocation wheats, with a few notable exceptions such as the West German variety Disponent and possibly the U.S. variety Siouxland (J. W. Schmidt, *personal communication*), possess these quality defects.

To date, studies of the effects of the 1B/1R translocation on the quality of bread wheats have concentrated on the "sticky dough" syndrome and its causes (Zeller et al 1982). Less attention has been given to the wide range of other quality characteristics of importance to end users of bread wheats. As a consequence, the

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present study was designed to provide systematic and comparative data on the milling properties and a range of quality characteristics of three Australian commercial cultivars and their backcross derivatives containing the 1B/1R translocation.

## MATERIALS AND METHODS

The backcross derivatives and their respective recurrent parents used in this study are described in Table I. Cook and Oxley are Australian prime hard and northern hard quality wheats, respectively, whereas Egret is a soft biscuit wheat. Aurora, which has been used in many breeding programs as a source of the 1B/1R translocation, and Burgas, a 1B/1R substitution line, were included for comparative purposes. SUN 89C, SUN 89D, SUN 89E, SUN 89F, and SUN 89G are sister lines with Cook as a major recurrent parent. SUN 91A, SUN 91B, and SUN 91C are also sister lines derived from Cook but with a slightly different pedigree. M 3344, M 3345, M 3346, M 3501, and M 3502 are sister lines with Oxley as the major recurrent parent. M 3342-2, M 3342-12, M 3342-20, M 3623, and M 3775 are sister lines derived from Egret where Skorospelka was the donor of the 1R chromosome. M 4174, with Kavkaz as a donor of the rye chromosome segment, WW 342, and WW 345 are also Egret backcross lines. All the lines were sown in the field at the I.A. Watson Wheat Research Centre, Narrabri, NSW, Australia during early June 1985 and harvested during late November 1985. Aurora and Burgas were grown in winter wheat trials during 1984.

The seeds were conditioned overnight to 15% moisture content and milled on a Brabender Quadrumat Senior mill. Flour and grain protein contents were determined on a Technicon Infra-alyzer 300 previously calibrated against Kjeldahl protein nitrogen. Flour water absorption and dough development time were determined on a microscale with 10 g of flour using a Brabender Micro-Farinograph. Dough extensibility and resistance to extension were measured with a Brabender Micro-Extensograph. The SDS-sedimentation test was performed using the method described by Preston et al (1982), and the sedimentation volume was recorded after 40 min. Baking experiments for Cook and SUN 89D were carried out at the Bread Research Institute of Australia at North Ryde, Sydney, following the method described by Moss (1980). Loaf volume was measured by seed displacement, and the following point system was used to arrive at a loaf score: volume, 36; external appearance, 20; texture, 30; and crumb color, 14. A chrondrometer was used for determining the test weight, which was expressed in kilograms per hectoliter. Falling number determinations of the sound grains were made on 7.0 g of wheatmeal according to ICC specification number 107 (ICC 1968). Flour color grade was estimated on dry flour samples using a Technicon Infra-alyzer 300 equipped with a 546-nm filter (Technicon color index filter) that had been previously calibrated using a Kent-Jones and Martin series 11 color grader (Kent-Jones and Amos 1967). The coefficient of correlation between Infra-alyzer data and Kent-Jones and Martin color grade results was very high ($r^2 = 0.93$). Ten grams of sample free of broken grains was pearled for 60 sec, and resistance to pearling was used as an index of grain hardness. Mixograms were produced on a 10-g mixograph. All measurements are means of three replications with the exception of milling, farinograph, and baking properties.

## RESULTS AND DISCUSSION

The quality measurements of hard and soft wheat lines containing the 1B/1R chromosome translocation were compared with those of their recurrent parents (Table II). The 1B/1R lines in which Cook and Oxley are the major recurrent parents differed from each other and their respective recurrent parents in some of the quality characteristics. All the 1B/1R lines in which Cook was a major parent had higher flour and grain protein contents. However, previous data from advanced variety selection trials at different sites indicated that differences in flour protein content between Cook and 1B/1R derivatives were not significant. Further, no significant differences were evident in the flour protein contents of Oxley and Egret 1B/1R derivatives and their respective parents.

There was no significant difference in flour yield and test weight among 1B/1R derivatives and their respective parents, Cook, Oxley, and Egret. However, some of the 1B/1R lines (SUN 89E, SUN 89F, and SUN 91B) had lower flour yield and test weight than Cook. One-thousand-grain weight was significantly higher in most translocation lines of the SUN 89 family. Only one 1B/1R line, M 3344, had higher grain weight where Oxley was a major recurrent parent. Most of the soft wheat lines containing the translocation chromosome (except M 4174 and WW 342) had 1,000-grain weights similar to Egret. The grain hardness of SUN 89C, SUN 89D, SUN 89E, and SUN 91C was similar to Cook, whereas it was reduced in SUN lines 89F, 89G, 91A, and 91B. All Oxley 1B/1R derivatives had higher grain hardness than Oxley, while there was little difference between Egret and its 1B/1R derivatives. There was no difference in falling number between 1B/1R translocation lines and their respective recurrent parents. The falling number (sec) range was 433–488 in Cook 1B/1R lines (Cook, 479); 410–422 in Oxley 1B/1R lines (Oxley, 411) and 364–395 in Egret 1B/1R lines (Egret, 371).

The SDS-sedimentation volume, which has been used as a screening test for breadmaking quality of wheat cultivars (Blackman and Gill 1980, Moonen et al 1982, Preston et al 1982), was generally decreased in the translocation lines derived from Cook and Oxley (Table III). The mean SDS volume for the 1B/1R derivatives of Cook was roughly equal to the mean of the recurrent parent and Aurora, the 1B/1R donor. On the other hand, the soft wheat, Egret, gave almost the same SDS volume as that of its 1B/1R derivatives except M 4174 and WW 342, which had higher volumes than Egret. For the first set of samples consisting of hard wheats only ($n = 15$), SDS volume showed a significant correlation with dough development time ($r = 0.53$*; * = at the 0.05 level) and width of the mixograph tail ($r = 0.59$*) (Table IV). However, in the second set, which included both hard and soft wheats ($n = 26$), SDS volume was significantly correlated with mixograph height and dough strength parameters (both resistance and extensibility) as well. High correlations between SDS volume and dough strength parameters have been reported in bread wheats (Moonen et al 1982, Preston et al 1982) and in durum wheats (Dexter et al 1980, Quick and Donnelly 1980). The poor correlation between flour protein and SDS volume obtained in the present study strengthened the view that the SDS-sedimentation test measured protein quality rather than differences in protein content (Preston et al 1982). Zeller et al (1982) reported no significant differences in sedimentation volume among a number of translocation lines, substitution lines, and their recurrent parents. The average baking scores (%) and loaf volumes of Cook and SUN 89D from different sites were strikingly similar (Table V).

There was an increase in the farinograph water absorption and decrease in dough development time in some of the 1B/1R lines where Cook was a major recurrent parent. The low water absorption in Oxley, Egret, and their 1B/1R derivatives may be a result of their lower flour protein compared to Cook and its translocation lines. Water absorption is significantly correlated with the flour protein ($r = 0.84$* to $r = 0.92$**; ** = the 0.01 level) in

**TABLE I**
**Pedigrees of 1B/1R Translocation Lines Used**

| Variety | Pedigree[a] |
|---|---|
| SUN 89D,E,F,G,H | Cook*3/3/2*Timaglen/Aurora/Kalyansona-Bluebird |
| SUN 91A,B,C | 2*Cook/3/Aurora/Kalyansona-Bluebird//Timgalen 2* |
| M 3344, M3345, M3346, M3501, M3502 | Kavkaz/Timgalen/3*Oxley |
| M3342-2, M 3342-12, M 3342-20, M 3623 | Skorospelka/4*Egret |
| M 3775 | Skorospelka/3*Egret |
| M 4174 | Kavkaz/2*Egret |
| WW 342, WW 345 | Skorospelka/3*Egret |

[a] Pedigree notation according to Purdy et al (1968).

TABLE II
Quality Measurements of 1B/1R Translocation Wheats and Their Recurrent Parents

| Wheat/ Derivative | Flour Protein (%) | Grain Protein (%) | Flour Yield (%) | 1,000-Grain Wt (g) | Test Wt (kg/hl) | Pearling Resistance (g) | Color Grade[a] |
|---|---|---|---|---|---|---|---|
| Cook | 11.3 | 12.1 | 76.8 | 40.2 | 87.0 | 5.1 | −0.3 |
| SUN 89C | 11.7 | 13.2 | 75.0 | 44.6 | 87.0 | 5.0 | −0.2 |
| SUN 89D | 11.9 | 13.3 | 74.7 | 44.3 | 86.1 | 5.0 | −0.2 |
| SUN 89E | 10.9 | 11.9 | 74.8 | 43.1 | 84.5 | 5.1 | −0.6 |
| SUN 89F | 13.6 | 15.6 | 73.4 | 43.5 | 83.0 | 4.6 | −0.4 |
| SUN 89G | 14.6 | 15.9 | 77.2 | 40.0 | 85.5 | 4.3 | 0.5 |
| SUN 91A | 11.3 | 12.5 | 76.4 | 40.6 | 86.4 | 4.9 | −0.6 |
| SUN 91B | 14.1 | 16.2 | 73.1 | 42.4 | 83.6 | 4.4 | −0.2 |
| SUN 91C | 11.6 | 12.4 | 76.5 | 39.2 | 86.4 | 5.1 | −0.4 |
| Oxley | 9.6 | 10.4 | 71.3 | 40.9 | 82.0 | 4.0 | −0.3 |
| M 3344 | 9.6 | 10.7 | 73.8 | 43.1 | 83.6 | 5.4 | −0.6 |
| M 3345 | 9.2 | 10.8 | 74.1 | 38.2 | 84.5 | 5.8 | −1.2 |
| M 3346 | 9.0 | 10.7 | 73.9 | 40.7 | 83.9 | 5.7 | −1.5 |
| M 3501 | 9.0 | 10.4 | 74.9 | 38.8 | 86.4 | 5.3 | −1.4 |
| M 3502 | 9.9 | 11.7 | 75.0 | 36.4 | 83.9 | 5.3 | −1.3 |
| Aurora[b] | 14.1 | 15.5 | 68.7 | 41.4 | 80.1 | 4.6 | −0.2 |
| Burgas[c] | 14.5 | 15.4 | 70.0 | 36.9 | 77.6 | 4.8 | −1.2 |
| Egret | 9.8 | 11.0 | 72.9 | 43.1 | 82.3 | 4.6 | −3.0 |
| M 3342-2 | 10.0 | 11.9 | 71.9 | 43.3 | 83.0 | 4.6 | −2.6 |
| M 3342-12 | 9.6 | 11.6 | 70.6 | 43.6 | 84.8 | 4.9 | −2.9 |
| M 3342-20 | 10.0 | 12.3 | 70.7 | 44.1 | 84.5 | 4.9 | −2.8 |
| M 3623 | 10.2 | 12.4 | 73.1 | 32.4 | 84.8 | 4.8 | −2.8 |
| M 3775 | 9.9 | 11.9 | 71.0 | 44.4 | 84.5 | 4.3 | −3.0 |
| M 4174 | 9.8 | 11.6 | 74.2 | 45.0 | 84.3 | 4.6 | −3.0 |
| WW 342 | 9.6 | 11.9 | 74.8 | 48.4 | 85.4 | 4.5 | −2.3 |
| WW 345 | 10.0 | 12.2 | 71.4 | 42.1 | 86.3 | 4.7 | −2.2 |
| LSD at 1% | 0.3 | 0.2 | ··· | 1.9 | 2.8 | 0.2 | 0.3 |

[a] Technicon Infra-alyzer 300B, with a 546-nm filter, calibrated against Kent-Jones & Martin color grader series II (30 g of flour, 50 ml of distilled water, and 115 sec mixing time).
[b] 1B/1R donor.
[c] 1B/1R substitution wheat.

TABLE III
SDS-Sedimentation[a] Volume, Farinograph and Extensigraph Properties of 1B/1R Translocation Lines and Their Respective Parents

| Wheat/ Derivative | SDS-Sedimentation Volume (ml) | Farinograph | | Extensigraph | |
|---|---|---|---|---|---|
| | | Water Absorption (%) | Development Time (min) | Resistance (BU)[b] | Extensibility (cm) |
| Cook | 71.0 | 63.4 | 4.2 | 445 | 18.4 |
| SUN 89C | 56.5 | 65.0 | 2.5 | 330 | 17.0 |
| SUN 89D | 60.0 | 65.3 | 2.5 | 312 | 16.2 |
| SUN 89E | 59.5 | 64.5 | 3.0 | 432 | 16.8 |
| SUN 89F | 57.0 | 66.5 | 3.0 | 368 | 17.5 |
| SUN 89G | 55.0 | 66.4 | 3.2 | 310 | 16.7 |
| SUN 91A | 55.5 | 63.2 | 2.0 | 200 | 19.5 |
| SUN 91B | 57.0 | 67.4 | 2.2 | 220 | 18.3 |
| SUN 91C | 61.0 | 64.0 | 2.5 | 260 | 19.1 |
| Oxley | 72.0 | 58.8 | 3.0 | 330 | 19.0 |
| M 3344 | 57.0 | 59.0 | 2.0 | 248 | 16.1 |
| M 3345 | 63.0 | 58.6 | 2.0 | 279 | 18.2 |
| M 3346 | 58.0 | 58.8 | 2.5 | 288 | 17.4 |
| M 3501 | 61.0 | 59.2 | 2.5 | 253 | 18.6 |
| M 3502 | 61.0 | 58.0 | 2.5 | 293 | 18.6 |
| Aurora | 47.5 | 64.0 | 3.5 | 410 | 18.7 |
| Burgas | 37.0 | 63.3 | 1.5 | ··· | ··· |
| Egret | 43.5 | 57.0 | 1.0 | 180 | 19.6 |
| M 3343-2 | 40.0 | 56.5 | 1.2 | 235 | 14.0 |
| M 3342-12 | 41.0 | 56.5 | 1.5 | 240 | 15.0 |
| M 3342-20 | 40.0 | 56.7 | 1.0 | 220 | 17.1 |
| M 3623 | 38.0 | 57.3 | 1.2 | 195 | 15.8 |
| M 3775 | 37.0 | 55.5 | 1.0 | 190 | 14.4 |
| M 4174 | 49.0 | 56.8 | 1.0 | 320 | 15.8 |
| WW 342 | 49.0 | 57.5 | 1.2 | 178 | 16.3 |
| WW 345 | 44.0 | 57.7 | 1.0 | 220 | 14.2 |
| LSD at 1% | 1.7 | ··· | ··· | 41.3 | 2.6 |

[a] SDS = sodium dodecyl sulfate.
[b] BU = Brabender units.

both sets of the samples (Table IV). The extensigraph resistance was generally decreased in all the translocation lines (except SUN 89E) of Cook and Oxley, whereas no change was noticed in soft wheats except M 3342-2, M 3342-12, and M 4174, which had higher resistance than Egret. The dough extensibility of some of the 1B/1R lines remained very close to their respective parents in hard wheats, however, it was lower in all the Egret translocation lines. Dough strength parameters (both resistance and extensibility) had a significant correlation with SDS volume, dough development time, mixograph height, and width of mixograph tail (Table IV).

Mixing tolerance is the ability of a dough to withstand overmixing and resist subsequent breakdown if the dough development time is exceeded. This can be assessed with a mixograph, which is often used to predict important physical dough and breadmaking properties in the early generations of wheat breeding programs (Finney and Shogren 1972, Bruinsma et al 1978). Figure 1 shows the mixograms of three Australian commercial wheats—Cook, Oxley, and Egret—and one 1B/1R translocation wheat derived from each variety. Most of the 1B/1R translocation derivatives of Cook and Oxley had shorter development times than their respective parent, indicating weaker doughs. The reduction in height of the mixograms may also indicate lower flour protein contents. The correlations between mixograph properties (mixograph height and width of the tail after 7 min of mixing) and flour protein, SDS volume, water absorption, dough development time, dough resistance, and extensibility were obtained (Table IV). Mixograph height had a significant correlation with flour protein ($r = 0.65^{**}$ to $r = 0.89^{**}$), SDS volume ($r = 0.70^{**}$ second set), water absorption ($r = 0.85^{**}$ to $r = 0.89^{**}$), dough development time ($r = 0.55^{*}$ to $0.83^{**}$), and dough resistance ($r = 0.48^{*}$ second set). Dough breakdown can be predicted from a decrease in height and width of the mixogram tail after 7 min of mixing or at some point after the peak height of the mixograph has been reached. Dough breakdown in wheat flour doughs has been studied

TABLE IV
**Correlation Coefficients Between Flour Protein, SDS-Sedimentation[a] Volume, Farinograph, Mixograph, and Extensigraph Properties of Hard and Soft Wheats and Their 1B/1R Derivatives**

| Properties | Flour Protein | SDS Volume | Water Absorption | Dough Development Time | Mixograph Height | Mixograph Width | Dough Resistance |
|---|---|---|---|---|---|---|---|
| Hard wheats ($n$ = 15) | | | | | | | |
| SDS Volume | −0.40 | | | | | | |
| Water absorption | 0.92**[b] | −0.38 | | | | | |
| Dough development time | 0.25 | 0.53*[b] | 0.26 | | | | |
| Mixograph height | 0.89** | −0.09 | 0.85** | 0.55* | | | |
| Mixograph width | 0.12 | 0.59* | 0.12 | 0.76** | 0.44 | | |
| Dough resistance | 0.09 | 0.45 | 0.20 | 0.83 | 0.37 | 0.72** | |
| Dough extensibility | −0.13 | 0.37 | −0.19 | 0.05 | −0.15 | −0.06 | −0.06 |
| Hard and soft wheats ($n$ = 26) | | | | | | | |
| SDS Volume | −0.01 | | | | | | |
| Water absorption | 0.84** | 0.44* | | | | | |
| Dough development time | 0.43* | 0.76** | 0.69** | | | | |
| Mixograph height | 0.65** | 0.70** | 0.89** | 0.83** | | | |
| Mixograph width | 0.22 | 0.79** | 0.51** | 0.82** | 0.74** | | |
| Dough resistance | 0.06 | 0.62** | 0.35 | 0.74** | 0.48* | 0.76** | |
| Dough extensibility | −0.26 | 0.52** | 0.03 | 0.34 | 0.24 | 0.40* | 0.60** |

[a] SDS = sodium dodecyl sulfate.
[b] *, ** Significant at the 5 and 1% levels, respectively.

TABLE V
**Baking Data for Cook and SUN 89D (a 1B/1R translocation line) Grown at Different Sites During 1984**

| | Flour Protein (%) | | Baking Score (%) | | Loaf Volume (ml) | |
|---|---|---|---|---|---|---|
| Site | Cook | SUN 89D | Cook | SUN 89D | Cook | SUN 89D |
| Myall Vale | 10.6 | 10.9 | 69 | 70 | 685 | 670 |
| Narrabri Early | 13.0 | 14.0 | 78 | 68 | 760 | 680 |
| Narrabri Late | 13.8 | 13.6 | 82 | 79 | 880 | 850 |
| Moree | 12.5 | 12.7 | 72 | 72 | 725 | 730 |
| Biniguy | 14.1 | 14.1 | 81 | 82 | 880 | 860 |
| Gulargambone | 15.5 | 15.4 | 78 | 86 | 780 | 860 |
| Mean | 13.3 | 13.5 | 76.7 | 76.2 | 785 | 775 |

extensively by Hoseney and co-workers and this work was reviewed by Hoseney (1985). Factors responsible for rapid dough breakdown during mixing may also be responsible for some of the other rheological problems associated with the translocation derivatives. Similarly, the apparent lack of effect of the 1R chromosome segment in the Egret background may be because Egret itself has a very poor mixing tolerance (Fig. 1E). The tail of the mixograph trace was thin in almost all the 1B/1R hard wheats, whereas there was no difference in soft wheats. The width of tail (measured after 7 min of mixing) had a correlation with SDS volume ($r$ = 0.59* to $r$ = 0.79**), dough development time ($r$ = 0.76** to $r$ = 0.82**), dough resistance ($r$ = 0.72** to $r$ = 0.76**), and dough extensibility ($r$ = 0.40* second set). The doughs generally broke down soon after attaining the peak height in poor quality wheats such as Aurora and Burgas. If mixed beyond this point, the doughs developed into a sticky mass.

## CONCLUSIONS

The present study indicates that the 1B/1R translocation does not generally have deleterious effects on grain size, test weight, grain and flour protein, milling quality, or farinograph water absorption. There were, however, some significant translocation-background interaction effects for these traits. For example, the Cook derivatives carrying the 1B/1R translocation had higher protein and, as an apparent consequence, higher farinograph water absorption than their recurrent parents. Further, the Oxley derivatives carrying the 1B/1R translocation had consistently harder grain, as evidenced by higher pearling resistance than their recurrent parents. However, previous experience suggests that the difference between Cook and its 1B/1R derivatives in protein

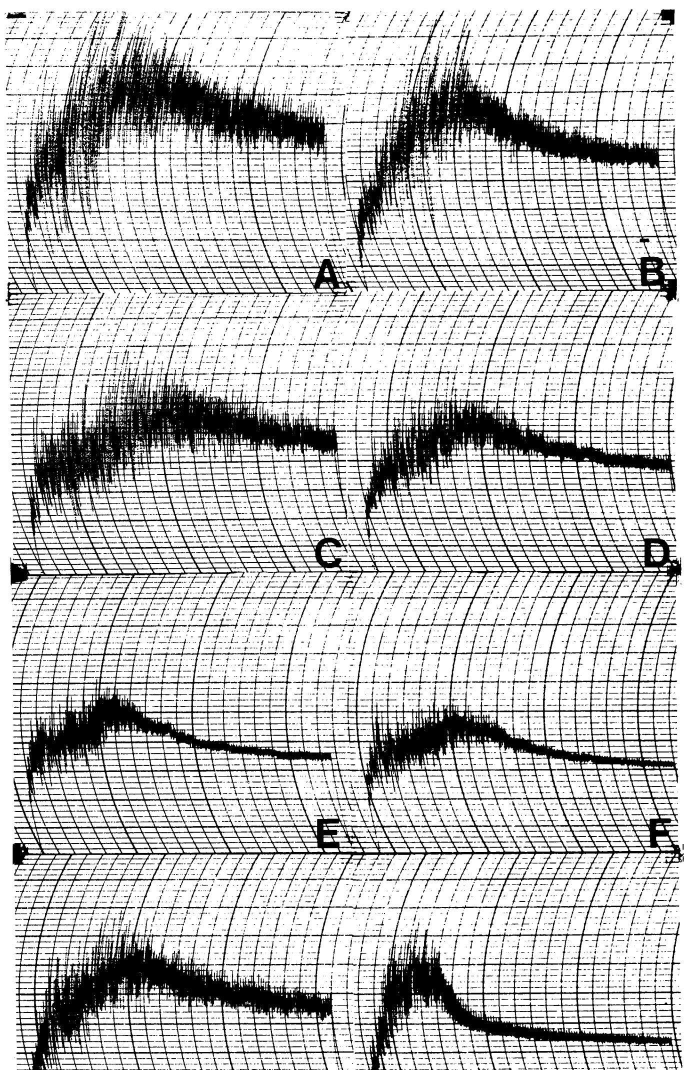


**Fig. 1.** Mixograms of flours (10 g) of three Australian commercial wheats: Cook (**A**) and its 1B/1R derivative SUN 89D (**B**); Oxley (**C**) and its 1B/1R derivative, M3344 (**D**) and Egret (**E**) and its 1B/1R derivative, WW345 (**F**). Aurora (**G**) and Burgas (**H**) are 1B/1R translocation and 1B/1R substitution lines, respectively.

varies with environment and is not a general phenomenon. The effects of 1B/1R translocation on grain hardness in Oxley derivatives warrants further investigation.

On the other hand, in the hard wheats the 1B/1R translocation had substantial and consistent deleterious effects on SDS-sedimentation volume and dough-development time. There was also a tendency towards reduced extensigraph resistance and extensibility. However, for the latter characters at least some of the 1B/1R translocation derivatives were similar to the recurrent parents, indicating that it would be a simple task to select for acceptable values of these traits in 1B/1R wheats. There was also some variation among the 1B/1R derivatives of Cook and Oxley for SDS-sedimentation volume and mixing time. However, none of the 1B/1R derivatives were equal to the recurrent parent with respect to SDS volume and mixing time indicating that it is likely to be a difficult task overcoming these particular adverse effects of the rye chromosome segment.

In sharp contrast to the situation in hard wheats, there was no evidence that the 1B/1R translocation reduced SDS sedimentation volume, dough development time, or extensigraph resistance in the derivatives of the soft wheat, Egret. However, the 1B/1R derivatives of Egret had markedly and consistently lower dough extensibilities compared to their recurrent parent. For all these traits it is not known whether the differences between the soft and hard wheats are general ones or specific to the genetic background used; this point obviously needs further investigation.

Overall, the data indicate that it should be possible to develop hard wheats carrying the 1B/1R translocation that approach their recurrent parents in all quality parameters examined here except SDS-sedimentation volume and dough-development time. Reduced dough development time may not necessarily be seen as a defect. In the Cook derivatives, decreased development may be an advantage because the development time of Cook is regarded as too long by commercial industry in Australia. In soft wheats, the present results suggest that it may be possible to develop 1B/1R translocation lines that are acceptable for all tests reported here and equal to their recurrent parents.

How the deleterious effects of the 1B/1R translocation on SDS-sedimentation volume and dough-development time relate to the sticky dough syndrome is currently unknown. It is unclear whether these effects are related phenomena or represent separate and independently controlled effects of the 1B/1R translocation on quality. These points are currently under investigation.

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