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Short Communication

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The Effect of Chromosome 1B/1R Translocation on the Yield Potential of Certain Spring Wheats (*Triticum aestivum* L.)

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With 2 tables

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Abstract

Nearly 50 percent of the 1988 advanced breeding lines of the CIMMYT bread wheat breeding program possess the 1B/1R homozygous translocation. Hence, a trial was conducted to estimate the effect of 1B/1R chromosome translocation on the yield potential of some of our high-yielding spring wheats, where non-limiting levels of fertility, moisture, preventive pest and disease programs were used. In conclusing the 1B/1R lines seemed to have increased their above-ground biomass yield, number of spikes per meter^2, 1000-grain weight and test weight. They also exhibited a slight advantage over the 1B homozygous lines on grain yield. The observed difference, however, was non-significant, as was the plant height difference observed among the two groups. Varietal comparisons indicated that the 1B/1R group headed later than the 1B group.

Key words: *Triticum aestivum* — *Secale cereale* — 1B/1R translocation — yield components — performance

Materials with translocation of the short arm of chromosome 1R of rye and the long arm of chromosome 1B of wheat have been successfully incorporated into many hexaploid wheat cultivars (Bartos et al. 1973, Cai and Liu 1989, McIntosh 1983, Merker 1982, Mettin et al. 1973, Mujeeb-Kazi 1982, 1983, Zeller 1973) and to a limited extent in *T. turgidum* wheats (Friebe et al. 1987, 1989). The 1B/1R translocation lines show a race specific resistance to leaf, stem and stripe rusts (*Lr26*, *Sr31*, *Yr9*) as well as powdery mildew (*Pm8*) (McIntosh 1983), with circumstantial evidence suggesting that 1B/1R lines may also possess resistance to *Septoria tritici* blotch, moderate tolerance to aluminum toxicity, plus high yield, stability and adaptability (Rajaram et al. 1983).

Cytogenetic analyses at CIMMYT have shown that nearly 50 percent of the advanced breeding lines of the 21st IBWSN (International Bread Wheat Screening Nursery) have the 1B/1R translocation. These lines were derived from crosses between Mexican spring semidwarfs and the 1B/1R winter wheat germplasm source from USA and USSR (Bartos et al. 1973, Merker 1982, Mettin et al. 1973, Zeller 1973). The breeding methodology employed to generate this germplasm has been described earlier (Dubin and Rajaram 1982, Rajaram et al. 1984).

The present study has attempted to measure the yield contribution of the 1B/1R chromosome translocation on some of our high yielding spring wheats.

Materials: Ten genotypes of spring wheat (*Triticum aestivum* L.) derived from the CIMMYT wheat program were selected for the experiment, representing a sample of the most high-yielding varieties and advanced lines.

Cytology for 1B/1R detection: Root tips were collected from 10 seedlings of each of the 10 genotypes and their respective plants were grown to maturity

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for multiplication. The root tips were pre-treated for 3 hours 30 minutes in an 8-hydroxyquinoline + colchicine + dimethylsufoxide solution according to MUJEEB-KAZI and MIRANDA (1985). They were then fixed in 0.1 % aceto-carmine for 48 hours, squashed in 45 % acetid acid and processed on dry ice for permanent slides. Giemsa procedure was applied in a manner essentially similar to that described by BENNETT et al. (1977).

Yield component investigation: Genotypes were grown at the Mexican Institute of Forestry, Agriculture and Livestock (INIFAP) irrigated research station (27° 20'N, 105° 55'W, elevation 40 m above sea level) in the Yaqui Valley, Sonora, Mexico, during the 1988/89 wheat production season. A randomized complete block design was used with four replications. Each plot consisted of eight rows, with each row being 5 m long and 20 cm apart. The experiment was sown at approximately 120 kg/ha and first irrigated on December 1, 1988.

The trial received high levels of agronomic inputs and management regarding fertilizer (150 kg N/ha and 40 kg P/ha), irrigation (as required until the latest maturing genotype reached physiological maturity), weed control (selective herbicide) and Bayleton for disease control (leaf rust and stem rust), while an insect control program was not required at any time during the season.

When mature, the crop from the central 3.75 m^2 of each plot was hand harvested by cutting at the ground level. The outer row and a 0.5 m border at each end of a plot were excluded from the samples. The procedure used in determining grain yield and its components was essentially similar to that described by WADDINGTON et al. (1986).

All measured variables were subjected to analysis of variance procedures. The general means of the 1B/1R cultivars and non-1B/1R cultivars were subjected to orthogonal contrast comparisons.

As revealed by routine somatic cytology, the translocation lines have 4 satellited chromosomes (6B and 5D) as opposed to 6 (1B, 6B, 5D) in euploid *Triticum aestivum* (JAHAN et al. 1990, MUJEEB-KAZI and MIRANDA 1985). Chromosome banding precludes any erroneous interpretation, the 1B/1R translocated chromosome being characterized by prominent banding sites on the terminal end of the long-arm, at the centromeric region, terminal and sub-terminal sites on the short-arm, with a fainter interstitial banded site on the long arm. Based upon this diagnosis, the 1B/1R lines were identified as 'Bagula', 'Kauz', 'Seri 82', 'Parula/Veery #6', and 'Veery 10', with the remaining 5 being 1B homozygous (Table 1).

Measurements taken for relevant characteristics of yield of 1B/1R genotypes and the non-1B/1R cultivars, respectively, are summarized in Table 2. Mean differences of characters observed in both groups have also been calculated.

The grain yield mean of the five 1B/1R genotypes was 5883.44 kg/ha as compared to 1B yields of 5866.20 kg/ha, but this difference was not significant ($P > 0.05$). Grain yield in this experiment was not limited by nitrogen, water, weeds or disease and no incidence of lodging

Table 1. Parentage of certain spring wheat cultivars/advanced lines (*Triticum aestivum* L.) with and without 1B/1R translocation

Cultivar/ advanced line	Parentage
Bagula*	Teeter/Junco
Kauz*	Jupateco/Bluejay//Ures
Seri 82*	Kavkaz/Buho//Kalyansona/Bluebird
Parula/Veery # 6*	Parula/Veery # 6
Veery 10*	Kavkaz/Buho//Kalyansona/Bluebird
Ciano 79**	Bucky/Maya/4/Bluebird//HD832.5.5/Olesen/3/Ciano 67/Penjamo
Opata 85**	Bluejay/Jupateco
Esmeralda 86**	Buckbuck/Bluejay
Yecora 70**	Ciano/Sonora 64//Klein Rendidor/3/8156
Oasis 86**	Agatha/3*Yecora

* Cultivars/advanced lines with 1B/1R translocation.
** Cultivars without 1B/1R translocation.

Table 2. The effect of the 1B/1R chromosome translocation on yield trial characteristics of 10 spring wheats, 5 with and 5 without the 1B/1R translocation

Plant characteristic (1)	Wheat lines with 1B/1R (2)	Wheat lines Non-1B/1R (3)	Difference (2)—(3) Mean (4)	Difference (2)—(3) C.V. (%) (5)
Plant height (cm)	88.1	89.5	1.4ns	3.1
Heading days	89.4	87.1	2.3***	1.5
Grain yield (kg/ha)	5883.44	5866.20	17.24ns	6.2
Above-ground biomass (t/ha)	14.5	13.9	0.6**	6.1
Harvest index (%)	38.0	39.5	1.5**	3.8
Grain no/m^2	14033.6	14078.5	44.9ns	7.0
Spike no/m^2	462.7	444.5	18.2*	6.3
Grain no/spike	30.5	31.4	0.9ns	7.5
1000-grain weight (g)	37.07	35.78	1.29***	2.6
Spike length (cm)	10.0	10.9	0.9***	6.1
Test weight (kg/hl)	80.3	79.2	1.1***	0.5

ns Not significant
* Significant at .05
** Significant at .01
*** Significant at .001

was observed during the experiment. However, the overall grain yield mean of the test materials (5874.82 kg/ha) was low as compared to the mean grain yield of bread wheat genotypes (6400 kg/ha) of earlier performance trials conducted at Ciudad Obregon (WADDINGTON et al. 1986). The low yield at present obtained is speculated to be due to reduced sunlight hours during December till the end of February 1989 and the high temperatures that prevailed during the grain filling stage of the crop (K. SAYRE, personal communication). The experiments' precision is reasonable with a 6.2 % coefficient of variation.

For plant height, comparison among translocation groups also has shown no significant difference ($P > 0.05$). But regarding heading days, the 1B/1R translocation material appeared to be 2.3 days later than the 1B material ($P < 0.001$). Very good coefficients of variations were calculated in both cases (plant height 3.1 %, heading days 1.5 %).

Above-ground biomass differences were detected between the 1B/1R and non-1B/1R cultivars, the mean for the 1B/1R lines (14.5 t/ha) being superior ($P < 0.01$) to that of the non-1B/1R cultivars (13.9 t/ha). On the other hand, the harvest index of the non-1B/1R group is significantly higher ($P < 0.01$) than the 1B/1R group.

Analysis of primary yield components indicated that 1B/1R lines had more spike bearing tillers than the non-1B/1R lines ($P < 0.05$). Similarly, the 1000-grain weight is higher in the 1B/1R lines than the non-1B/1R lines ($P < 0.001$). Test weight comparisons have also strongly indicated that 1B/1R lines have better formed plump grains (80.3 kg/hl vs. 79.2 kg/hl) at .001 level of probability. In contrast, the non-1B/1R lines have longer spikes ($P < 0.001$) as compared to 1B/1R materials. However, when grain number was compared on an area (m^2) and spike basis, no significant difference was observed ($P > 0.05$).

Summarizing among the different characters studied, genotypes with the 1B/1R chromosome translocation clearly possessed increased: above-ground biomass yield, number of spikes per m^2, 1000-grain weight and test weight. The slight advantage observed in the translocation lines for grain yield was not significant and inconclusive. These results require wider validation, in particular with other genetic backgrounds now dominating the CIMMYT bread wheat breeding program. Further work is being done by the authors on producing isogenic lines so the relative importance of the 1B/1R contributions can be better estimated. The case is equally strong for the examination of other environmental interactions, especially now that the 1B/1R germplasm is being increasingly used in various national wheat research programs (JAHAN et al. 1990, TERKUILE et al. 1990). It is also probable that after delineating the "adaptive" influence of the 1R segment in the 1B/1R lines a search for interactions with other major "adaptation" genes may prove beneficial in developing breeding strategies to optimize exploitation of this genetic component.

Zusammenfassung

Die Wirkung der 1B/1R-Chromosomen-Translokation auf die Ertragsfähigkeit bestimmter Sommerweizen (*Triticum aestivum* L.)

Ungefähr die Hälfte der 1988 von CIMMYT im Rahmen des Brotweizenzuchtprogramms entwickelten Linien besitzen die 1B/1R-Translokation homozygot. Um die Wirkung dieser Translokation auf die Ertragsfähigkeit unserer hochleistungsfähigen Sommerweizen zu ermitteln, wurde ein Versuch durchgeführt, bei dem eine ausreichende Nährstoff- und Wasserversorgung gewährleistet war. Gegen Krankheiten und Unkraut wurde vorbeugend behandelt. Folgende Merkmale wurden erfaßt: Pflanzenhöhe, Schoßtermin, Kornertrag, Biomasse, Harvest-Index, Ertragskomponenten und Hektolitergewicht. Die Translokation schien bei den untersuchten Genotypen den Ertrag an oberirdischer Biomasse, die Anzahl der Ähren/m^2, das Tausendkorngewicht und das Hektolitergewicht erhöht zu haben. Die 1B/1R-Linien wiesen darüber hinaus in bezug auf den Kornertrag gegenüber den homozygoten 1B-Linien einen kleinen Vorsprung auf, der jedoch nicht signifikant war. Hingegen war der beobachtete Unterschied in der Pflanzenhöhe zwischen diesen beiden Gruppen signifikant. Vergleichende Untersuchungen machten deutlich, daß die 1B/1R-Gruppe später schoßte als die 1B-Gruppe. Es wird vorgeschlagen, weitere Untersuchungen mit stärker variierenden genetischen Material durchzuführen.

References

BARTOS, P., J. VALKOUN, J. KOSNER, and L. SKOVENCIKOVA, 1973: Rust resistance of some European wheat cultivars derived from rye. Proc. 4th Intern. Wheat Genet. Symp. 1973, Columbia, Missouri. 145—146.

BENNETT, M. D., J. P. GUSTAFSON, and J. B. SMITH, 1977: Variation in nuclear DNA in the genus *Secale*. Chromosoma **61**, 149—176.

CAI, X., and D. LIU, 1989: Identification of a 1B/1R wheat-rye chromosome translocation. Theor. Appl. Genet. **77**, 81—83.

DUBIN, H. J., and S. RAJARAM, 1982: The CIMMYT's international approach to breeding disease-resistant wheat. Plt. Dis. **66** (10), 967—971.

FRIEBE, B., F. J. ZELLER, and R. KUNZMANN, 1987: Transfer of the 1BL/1RS wheat-rye-translocation from hexaploid bread wheat to tetraploid durum wheat. Theor. Appl. Genet. **74**, 423—425.

— —, M. HEUN, and W. BUSHUK, 1989: Cytological characterization, powdery mildew resistance and storage protein composition of tetraploid and hexaploid 1BL/1RS wheat-rye translocation lines. Theor. Appl. Genet. **78**, 425—432.

JAHAN, Q., N. TERKUILE, N. HASHMI, M. ASLAM, A. A. VAHIDY, and A. MUJEEB-KAZI, 1990: The status of the 1B/1R translocation chromosome in some released wheat varieties and the 1989 candidate varieties of Pakistan. Pak. J. Bot. (In Press).

MCINTOSH, R. A., 1983: A catalogue of gene symbols for wheat. Proc. 6th Intern. Wheat Genet. Symp. 1983, Plant Germplasm Inst., Kyoto. 1197—1255.

MERKER, A., 1982: "Veery" — a CIMMYT spring wheat with 1B/1R chromosome translocation. Cer. Res. Comm. **10**, 105—106.

METTIN, D., W. D. BLUTHNER, and G. SCHLEGEL, 1973: Additional evidence on spontaneous 1B/1R wheat-rye substitutions and translocations. Proc. 4th Intern. Wheat Genet. Symp. 1973, Columbia, Missouri. 179—184.

MUJEEB-KAZI, A., 1982: CIMMYT Report on Wheat Improvement. 78—87.

— —, 1983: CIMMYT Report on Wheat Improvement. 94—103.

— —, and J. L. MIRANDA, 1985: Enhanced resolution of somatic chromosome constrictions as an aid to identifying intergeneric hybrids among some *Triticeae*. Cytologia. **50**, 701—709.

RAJARAM, S., B. SKOVMAND, and B. C. CURTIS, 1984: Philosophy and methodology of an international wheat breeding program. Gene Manipulation in Plant Improvement. 33—60. Plenum Publishing Corporation

— —, C. E. MANN, G. ORTIZ-FERRARA, and A. MUJEEB-KAZI, 1983: Adaptation, stability and high yield potential of certain 1B/1R CIMMYT wheats.

Proc. 6th Intern. Wheat Genet. Symp. 1983, Plant Germplasm Inst., Kyoto. 613—621.

[illegible], N., Q. JAHAN, N. HASHMI, M. ASLAM, A. A. VAHIDY, and A. MUJEEB-KAZI, 1990: 1B/1R translocation wheat cultivars detected by A-PAGE electrophoresis and C-banding in the 1990 national uniform wheat yield trial (NUWYT) in Pakistan. Pakistan J. Sci. Indust. Res. (Submitted).

WADDINGTON, S. R., J. K. RANSOM, M. OSMANZAI, and D. A. SAUNDERS, 1986: Improvement in the yield potential of bread wheat adapted to northwest Mexico. Crop Sci. **26**, 698—703.

ZELLER, F. J., 1973: 1B/1R wheat-rye chromosome substitutions and translocations. Proc. 4th Intern. Wheat Genet. Symp. 1973, Columbia, Missouri. 209—221.

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