

ADAPTATION, STABILITY AND HIGH YIELD POTENTIAL OF CERTAIN 1B/1R CIMMYT WHEATS

S. RAJARAM, Ch. E. MANN, G. ORTIZ-FERRARA and A. MUJEEB-KAZI

*CIMMYT, Wheat Program, Londres 40, Apdo. Postal 6-41, Delg.
Cuauhtemoc 06600, Mexico, D.F., Mexico*

SUMMARY

CIMMYT-bred advanced lines of bread wheats such as Veery "S", Bobwhite "S" and Alondra "S" carry 1B/1R translocation. These lines were derived from three-way crosses between Mexican spring semidwarfs and winter wheat varieties Kavkaz and Aurora from Soviet Union and Weique Red Mace from United States, respectively. In general, based upon 6 years of testing, these varieties possess high yield potential and good rust resistance under Mexican conditions. In particular, the Veery "S" have shown high yield stability and wide adaptability in various world wheat growing environments. The selections from this cross have been released in Mexico, Pakistan, Paraguay, Zimbabwe and Chile. The yield potential and stability of Bobwhite "S" and Alondra "S" is slightly lower than Veery "S" in relation to the environments where these were tested. Nonetheless, Bobwhite "S" is highly resistant to *Septoria tritici* and Alondra "S" is moderately tolerant to aluminum toxicity, two major stresses present in many wheat growing countries.

INTRODUCTION

The production of widely adapted wheat cultivars with high and stable yields has been the most important objective of CIMMYT's wheat breeding program over the last two decades.

In collaboration with national breeding programs, such wheat varieties as Siete Cerros, Anza, Sonalika and Marcos Juarez Inta were developed that adapted to many environments and are now grown on millions of hectares (Dalrymple 1978). The development of these varieties was made possible through the application of multilocation shuttle breeding in Mexico (Borlaug 1968), through careful manipulation of semidwarfing genes and by engendering these cultivars with rust resistance and photo-period insensitivity.

In the 1970's, CIMMYT increasingly sought to expand the adaptation of its bread wheat germplasm. Greater emphasis was given to incorporating resistance to *Septoria tritici*, and to improving the performance of our cultivars under environmental stress conditions, such as drought and aluminum toxicity. Three-way crosses ($F_1 \times$ variety) were introduced and became a popular way to compress more genetic variability into individual lines thereby broadening horizons of wide adaptation (Rajaram and Dubin 1977). But it was the introduction of certain winter wheats from the USA and the USSR into CIMMYT's bread wheat crossing program that produced progenies of outstanding performance to warrant this report.

MATERIALS AND METHODS

The winter wheats from the USA and USSR that we used in our breeding program carried the 1B/1R translocation (Zeller 1973; Bartos *et al.* 1973; Mettin *et al.* 1973; Merker 1982). Three-way crosses with certain high yielding, photo-period insensitive, semi-dwarf wheats from Mexico resulted in the progenies Veery "S", Bobwhite "S" and Alondra "S" (parentage reported in Table 1). All three cultivars carry the 1B/1R translocation.

Selection of material was carried out at Ciudad Obregon, Sonora (27°20'N, 40 m above sea level), and at Toluca (19°N, 2649 m above sea level); both sites are in Mexico. These two environments are very different with respect to yield potential, environmental stresses, and climatic conditions. The breeding methodology employed by CIMMYT has been described elsewhere (Borlaug 1968; Dubin and Rajaram 1981).

Yield evaluations were made at Ciudad Obregon. Selections of Veery "S" were compared to Ciano 79, a variety widely grown in Mexico but one that does not have the 1B/1R translocation. In addition, the yields of Veery "S", Anza, Ciano 79 and the local checks are excerpted from the 16th, 17th and 18th International Spring Wheat Yield Nurseries (ISWYN). These nurseries are prepared and distributed by CIMMYT and then grown and evaluated by national wheat programs in many countries of the world. The variety Anza was chosen for comparative purposes because it is widely adapted and very stable. It is a CIMMYT developed variety released by the University of California at Davis, California, U.S.A. It was also released and grown in Algeria, Spain, Portugal, New Zealand, Australia, Chile, Iran and Sudan. It carries no 1B/1R translocation. The local checks are presented because they represent the most widely grown varieties at the time each test was conducted. The mean yields of these varieties in the 16th, 17th, and 18th ISWYN's are presented from 61, 57 and 35 locations respectively.

RESULTS AND DISCUSSION

1. Veery "S"

- a) Yield. Yield performance of Veery 1, Veery 2, Veery 3, and Veery 5 is compared to the widely grown variety Ciano 79 for the period of 1980-81 and 1981-82 (Table 2). Ciano 79 possesses high yield potential in Sonora State of Mexico and the Veery selections possess a comparable yield potential in that location. Veery "S" have been tested in Cd. Obregon for last 6 years, yet results given here are only for the last two years because of the lack of a common standard

Table 1. Parentage of Veery, Bobwhite and Alondra wheats.

Cultivar	Parentage
Veery	*Kavkaz-Buho × Kalyansona-Bluebird
Bobwhite	*Aurora-Woodpecker × Kalyansona-Bluebird
Alondra	D.6301-Nainari 60 × **Weique Redmace/Ciano67 ² -Chris

* Cultivars with 1B/1R translocation originating in U.S.S.R.

** Cultivar with 1B/1R translocation originating in U.S.A.

Table 2. Yield performance of certain CIMMYT wheats with and without 1B/1R translocation in Cd. Obregon, Mexico 1980-81 and 1981-82 seasons.

Cultivar	Yield kg/ha	
	1980-81	1981-83
Veery 1*	6778	6568
Veery 2*	6437	6691
Veery 3*	6300	6859
Veery 5*	6743	6423
Ciano 79**	6174	6889
L.S.D. (0.05)	500	617
C.V. (%)	6	6.8

* Cultivars with 1B/1R translocation

** Cultivar without 1B/1R translocation.

check over the entire 6 year period. In addition to high yield, Veery "S" have been found to be resistant to prevalent races of stem rust, leaf rust and stripe rust under Mexican field conditions. The milling and baking characteristics of Veery "S" are satisfactory.

- b) Wide adaptation. The international yield performance of Veery "S", Anza, Ciano 79 and a local check is given in Tables 3, 4 and 5 for 1979-80, 1980-81 and 1981-82 respectively. During this period these varieties were tested in 153 different environments worldwide. Veery 5, ranked number 1 in the 16th IS WYN (1979-80), compared to 17th place for Anza, 7th for Ciano 79 and 15th for the local check. On average, Veery 5 yielded 4339 kg/ha compared to the trial mean yield of 3698 kg/ha over all 61 locations (Table 3). In the 17th IS WYN (1980-81) performances of Veery 1, Veery 2, Veery 3 are compared to Anza, Ciano 79, and the local check (Table 4). Veery 2 occupies first place followed by Veery 1 and Veery 3; these rankings compare to 14th, 16th, and 6th positions for Anza, Ciano 79, and the local check, respectively. In this trial, Veery 2 occupied the top position, yielding on average 4337 kg/ha over 57 locations compared to the trial mean yield of 3667 kg/ha.

Table 3. Yield performance of certain CIMMYT wheats with and without 1B/1R translocation in worldwide testing (16th ISWYN 1979-80).

Cultivar	Yield kg/ha	Rank
Veery 5*	4339	1
Ciano 79**	4076	7
Local check	3883	15
Anza**	3773	17
Mean over locations	3698	
Number of locations	61	

* Cultivar with 1B/1R translocation.

** Cultivar without 1B/1R translocation.

Table 4. Yield performance of certain CIMMYT wheats with and without 1B/1R translocation in worldwide testing (17th ISWYN 1980–81).

Cultivar	Yield kg/ha	Rank
Veery 2*	4337	1
Veery 1*	4175	3
Veery 3*	4115	5
Local check	4109	6
Anza**	3911	14
Ciano 79**	3766	16
Mean over locations	3657	
Number of locations	57	

* Cultivars with 1B/1R translocation.

** Cultivars without 1B/1R translocation.

Table 5. Performance of certain CIMMYT wheats with and without 1B/1R translocation in worldwide testing (18th ISWYN 1981–82).

Cultivar	Yield kg/ha	Rank
Veery 5*	4265	1
Local check	4190	2
Veery 3*	4161	3
Veery 2*	4141	4
Veery 1*	3978	9
Ciano 79**	3972	10
Anza**	3896	11
Mean over locations	3577	
Number of locations	35	

* Cultivars with 1B/1R translocation.

** Cultivars without 1B/1R translocation.

In the 18th ISWYN (1981–82), Veery 5 again occupied the first position, while the local check ranked second (Table 5). Veery 3, Veery 2 and Veery 1 occupied 3rd, 4th and 9th positions, respectively, compared to 11th place for Anza and 10th place for Ciano 79. The top yielding variety, Veery 5, produced an average of 4265 kg/ha in 35 locations, compared to the trial mean yield of 3577 kg/ha.

The yield performances of Veery “S”, Anza, Ciano 79 and the local checks in different large geographic environments are presented in Tables 6 to 10. These zones are classified according to their similarities in climatic conditions and environmental stresses, though large variations do occur within each zone. The findings are summarized below:

- i) In the typically semiarid Middle East region, Veery “S” yielded slightly higher when compared to the local check and Anza (Table 6).
- ii) In the Southern Cone region of South America the performance of Veery “S” was again slightly higher (Table 7). Part of this region is highly acidic

Table 6. Yield performance of certain CIMMYT wheats with and without 1B/1R translocation in the region of Middle East (17th ISWYN 1980-81).

Cultivar	Yield kg/ha
	Middle East
Veery 2*	4962
Veery 1*	4676
Veery 3*	4775
Local check	4622
Anza**	4667
Ciano 79**	4267
Mean over locations	4220
Number of locations	8

* Cultivars with 1B/1R translocation.

** Cultivars without 1B/1R translocation.

Table 7. Yield performance of certain CIMMYT wheats with and without 1B/1R translocation in the region of Southern Cone countries of South America (17th ISWYN 1980-81).

Cultivar	Yield kg/ha
	Southern Cone
Veery 2*	3105
Veery 1*	3324
Veery 3*	3136
Local check	2938
Anza**	2266
Ciano 79**	2614
Mean over locations	2553
Number of locations	3

* Cultivars with 1B/1R translocation.

** Cultivars without 1B/1R translocation.

with aluminum toxicity problems. The area in general is a semi-arid, rain-fed production environment with a complex of disease problems.

- iii) In the highland regions of the Andes, East Africa, and Central America, including Central Mexico certain Veery selections yielded the same or slightly higher than the local check (Table 8). These environments typify high rainfall with a high incidence of foliar diseases.
- iv) In the region inclusive of northern Mexico and the southwestern U.S.A., Veery "S" yielded higher than local check (Table 9). These areas are irrigated and generally produce high yield.
- v) In the region of northern U.S.A./Canada, the Veery "S" yielded slightly higher than the local check (Table 10) whereas in northern Europe yields were a little lower than the local check. These regions typically require photo-period sensitive, adaptative varieties.

Table 8. Yield performance of certain CIMMYT wheats with and without 1B/1R translocation in the region of East Africa, Andean Region of South America and Highlands of Central America (17th ISWYN 1980-81).

Cultivar	East Africa	Andean Region	Central America Including Central Mexico
Veery 2*	3438	2884	5537
Veery 1*	3103	2384	5906
Veery 3*	3206	2485	6187
Local check	2227	2871	5163
Anza**	2536	1808	4698
Ciano 79**	2436	1683	5253
Mean over locations	2503	1771	5040
Number of locations	3	4	4

* Cultivars with 1B/1R translocation.

** Cultivars without 1B/1R translocation.

Table 9. Yield performance of certain CIMMYT wheats with and without 1B/1R translocation in the region of Northern Mexico and Southwestern Spring Wheat growing areas of U.S.A. (17th ISWYN 1980-81).

Cultivar	Yield kg/ha
	Northern Mexico/ Southwestern U. S. A.
Veery 2*	6357
Veery 1*	6327
Veery 3*	5779
Local check	5063
Anza**	5940
Ciano 79**	4989
Mean over locations	5028
Number of locations	4

* Cultivars with 1B/1R translocation.

** Cultivars without 1B/1R translocation.

These results amply demonstrate the wide adaptability of Veery "S" in many different environments when compared to locally adapted check varieties. Because of this wide adaptation characteristic and its high yield potential, many national programs have released Veery "S" for general cultivation. A partial list of releases is given in Table 11.

c) Stability

Yield stability is statistically defined here as a low mean square of the deviations of the location means of a particular cultivar from the regression line of these location means on the respective location grand means (Fig. 1).

Mean squares of deviations of all Veerys are equal to or smaller than that of Ciano 79 (locations with a C.V. < 20% have been eliminated, Table 12). This indicates good stability for high yield considering that the grand means of the 42

Table 10. Yield performance of certain CIMMYT wheats with and without 1B/1R translocation in the regions of Europe and Northern U.S.A./Canada (17th ISWYN 1980-81).

Cultivar	Yield kg/ha	
	European	Northern U. S. A. and Canada
Veery 2*	4782	4135
Veery 1*	4713	4138
Veery 3*	4514	4006
Local check	5214	3858
Anza**	4969	3521
Ciano 79**	4748	3795
Mean over locations	4407	3503
Number of locations	8	6

* Cultivars with 1B/1R translocation.

** Cultivars without 1B/1R translocation.

Table 11. Veery "S" as released varieties in different climatic zones.

Veery selection	Variety name	Country of release
Veery 1	Glennson 81	Mexico
Veery 2	Uies 81	Mexico
Veery 3	Genaro 81	Mexico
Veery 5	Seri 82	Mexico
Veery 5	Pakistan 81	Pakistan
Veery 3	Cordillera	Paraguay
Veery 3	Millaleu inta	Chile
Veery "S"	Lesapi	Zimbabwe
Veery 3	Lima 1	Portugal

environments range from 1.01 to 7.2 t/ha. In addition, the slope of the regression lines are above 1 (Table 12), which shows that all Veerys are input efficient, whereas Ciano 79 has a below average response to more favorable growing conditions. The positive intercept for all lines indicates that they are also yielding above average in low input environments.

2. Bobwhite "S"

Septoria tritici resistance in a semidwarf. Even though the yield potential, and wide adaptation of Bobwhite selections are slightly lower than Veery "S" in both Mexican and international environments, the Bobwhite "S" have shown good resistance to *Septoria tritici* in those environments where this disease is prevalent. This is an important achievement. Only a decade ago the scientific community postulated that the semi-dwarf characteristic may be genetically linked to *Septoria tritici* susceptibility, and that millions of hectares of these varieties could become vulnerable (Johnson 1972). Results of *Septoria* testing from Israel (Zahir Eyal, personal communica-

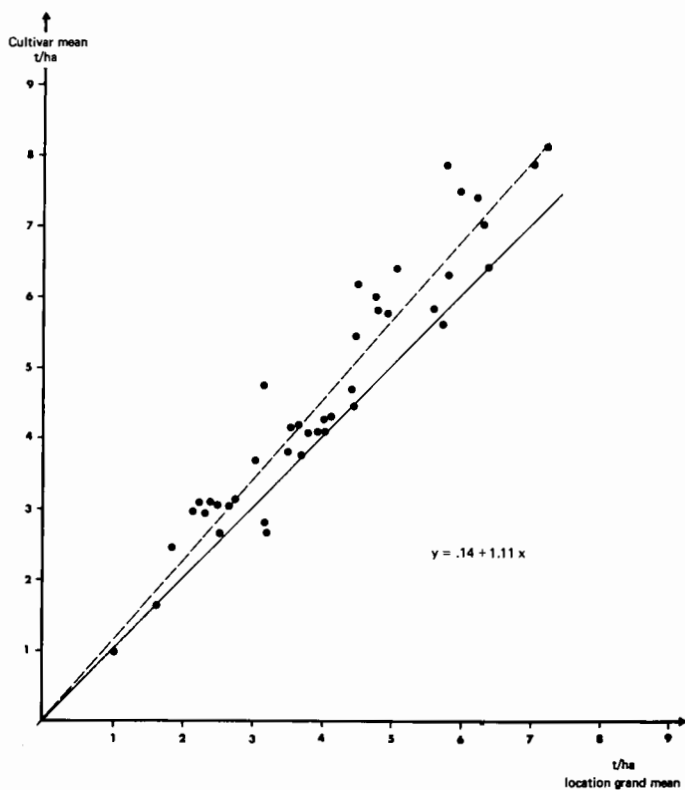


Fig. 1. Relation between location means of Veery 1 (broken line) and location grand means of 17th ISWYN (42 locations).

Table 12. Stability parameters of wheats with and without 1B/1R translocation in the 17th ISWYN.

Name	MS _{Dev}	b	a
Veery 1*	0.29	1.11	0.14
Veery 2*	0.41	1.23	0.16
Veery 3*	0.33	1.10	0.12
Veery 4*	0.37	1.05	0.16
Veery 5*	0.35	1.08	0.18
Ciano 79**	0.41	0.98	0.25

MS_{Dev}: Mean square deviations of the means of the line at each of 42 locations from their regression line.

b: Slope of the regression line of the means of the line at each of 42 locations on the respective location grand mean.

a: Intercept of the regression line with the Y-axis.

* Cultivars with 1B/1R translocation.

** Cultivars without 1B/1R translocation.

tion) and field evaluations in disease hazard areas of Argentina, the high plateau of Mexico, Middle East and North Africa have established Bobwhite "S" as being resistant to *Septoria tritici*.

3. Alondra "S"

Aluminum toxicity tolerance in a semidwarf. Before the production of Alondra "S", all semidwarf spring wheat varieties from Mexico were susceptible to aluminum toxicity in the acidic soils of Brazil in 1975-76, Brazilian scientists discovered that Alondra "S" was moderately tolerant to Al^{+++} toxicity. This discovery led Dr. C. F. Konzak of Washington State University at Pullman to research the mechanism of this resistance. According to Dr. Konzak (C. F. Konzak, personal communication) Alondra is susceptible to Al^{+++} toxicity, but efficiently utilizes P_2O_5 in P_2O_5 deficient soils, hence providing a moderate level of tolerance to Al^{+++} toxicity. Circumstantial evidence suggests that Al^{+++} tolerance has been contributed by the Weique-Red Mace parent of Alondra "S", as other parents, are highly susceptible to this stress. This variety has proven to be an outstanding-parent in breeding of Al^{+++} tolerant semidwarf wheat varieties (Rajaram *et al.* 1981), and has been released as Alondra 4546 by Organizacão Das Cooperativas do Estado do Parana (OCEPAR), State of Parana, Brazil, for general cultivation.

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