REPRINT Vol. 8 No. 3 1980

SOME INTERGENERIC HYBRIDS IN THE TRITICEAE

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SUMMARY

Intergeneric hybrids obtained in CIMMYT between some Triticeae were cytogenetically analyzed, and are discussed. A few possessed the maternal euploid composition, devoid of any detectable alien chromosomes. Other plants had the somatic counts expected from the cross-combinations. Hordeum vulgare x Triticum aestivum hybrids with a chiasmata frequency range of 2.47 to 2.63 per cell suggest homoeologous chromosome pairing. T. aestivum x Elymus giganteus had a mean of 1.2 rod bivalent formation. The H. vulgare x Elymus ($S_2S_2H_2H_2H_3H_3$, 2n=6x=42) hybrid with a lesser than expected mean chiasmata frequency (4.77) suggests an evaluation of the pairing relationships amongst the HH_2H_3 genomes. Backcross progenies were obtained in a few hybrids assisted by post-pollination gibberellic acid (75 ppm) application.

INTRODUCTION

Intergeneric hybridization attempts in the Triticeae other than wheat x rye hybridization, have been reported since the mid-1960's. The successes have provided a range of unique information on:

(i) Pseudogamous seed formation, KRUSE 1965

(ii) Generation of T. aestivum polyhaploids (2n=3x=21, ABD) BARCLAY 1975

(iii) Cytomorphological data of intergeneric hybrids FEDAK 1977, MUJEEB et al. 1978, THOMAS et al. 1977

(iv) Developing H. vulgare addition lines in T. aestivum background, ISLAM et al. 1975

and (v) Attaining meiotically regular and fertile amphiploids CHAPMAN and MILLER 1978, KIMBER and SALLEE 1976, and deriving a trigeneric hybrid from one amphiploid, KIMBER and SALLEE 1979.

Over the course of CIMMYT's Triticum based intergeneric hybridization program, a number of hybrids were produced. The genera included in this crossing program included Agropyron species, Elymus species, Hordeum vulgare, Secale species, Triticum monococcum, T. turgidum, T. timopheevii and T. aestivum. The morphocytogenetic observations of a few of the hybrids obtained are presented.

MATERIALS AND METHODS

The hybridization program was carried out at two locations: (i) El Batan, Mexico and (ii) CIANO, Obregon, Mexico. The objectives were to transfer to wheat the high protein and lysine from barley, salt tolerance from Agropyron distichum, rust resistance from Agropyron including amphiploid sources and species, drought characteristics from Elymus species, and lastly to better understand the complexities of intergeneric hybridization. Although the major emphasis was wheat based,

barley and species of other genera were also used as maternal parents. The crossing was under field conditions, and subject to availability of parental sources.

The techniques utilized manipulation of crossability barriers through:

(i) Genetic variability (THOMAS et al. 1977)

(ii) Pre-and/or post-pollination treatment of maternal plants with:

(a) Growth regulators (KRUSE, 1974) or

(b) Animal-effective immunosuppressants (BATES et al. 1974)

Pollination techniques and embryo recovery procedures were similar to those described by THOMAS et al. 1977.

Barley x T. aestivum, and T. aestivum x Elymus giganteus hybrids were backcrossed to both parents. The florets were clipped, pollinated, and treated by gibberellic acid (75 ppm), KRUSE, 1974. This study was conducted in the growth chamber under 14 h. day; 15.0°C day/10°C night, and 45% R.H.

MODIFICATIONS OF TECHNIQUES

Our studies at CIMMYT over the last 5 years and unpublished observations of A. M-K of 1979 have necessitated making modifications in the cross-manipulation procedure as follows:

(i) Post pollination treatment of florets with GA_3 (75 ppm) starting one day after pollination for 2 days, details in KRUSE 1974. The use of 2, 4- Dichlorophenoxy acetic acid as a pre-pollination treatment when wheat is the maternal parent is under test.

(ii) The use of E-Amino-n-Caproic acid to follow the post-pollination schedule of TAIRA and LARTER 1977, but reduced to two treatments (1000 ppm for wheat, and 500 ppm for barley)

(iii) Incorporate parents of demonstrated better crossability, THOMAS et al. 1977, and

(iv) Exploit environmental variability in conjuction with (i) to (iii), MUJEEB-KAZI (1980).

RESULTS AND DISCUSSION

Two categories of plant-types were retrieved after embryo culture:

A. Plants that maintain chromosomes from both parents.
are male-sterile, but produce backcross progeny

The hybrids after somatic and meiotic analysis have been vegetatively propagated by cloning. The hybrids obtained and maintained in CIMMYT are included in Table I. Some are cytologically confirmed (Table II), while the others are in various developmental stages and await cytological confirmation.

SOME HYBRIDS AND BACKCROSS PROGENIES

H. VULGARE L. cv. MANKER (2n=14, HH) x T. AESTIVUM (2n=6x=42, AABBDD) HYBRIDS

TABLE I. Some intergeneric hybrids obtained in CIMMYT

CIMMYT No. (Lab. or Greenhouse)	FEMALE PARENT	VARIETY	MALE PARENT	VARIETY	TREATMENT OF MATERNAL PARENT
L79.1112B	H. vulgare	Manker	T. aestivum	Bonza	EACA INJECTED (500 mg/l) Pre-Poll. + GA_3 Post-Pollination
L79.129A	"	"	"	"	NO TREATMENT
L79.129C	"	"	"	"	"
L79.129D	"	"	"	"	"
L79.115	"	"	"	Pavon	EACA INJECTED (500 mg/l) Pre-Poll. + GA_3 Post-Pollination
L79.122D	"	"	"	"	NO TREATMENT
L79.124C	"	"	"	"	"
L79.130	"	"	"	Chinese Spring	"
L79.401	T. aestivum	Zaragoza 75	H. vulgare	Manker	EACA INJECTED (1000 mg/l) Pre-Pollination
L79.1002	"	Chinese Spring	E. giganteus		NO TREATMENT
B79.1015	H. vulgare		Elymus (2n=6x=42)		"
L79.1442C	E. canadensis		H. vulgare	Manker	"
L79.1442D	"		"		"
L79.1442E	"		"		"

TABLE II Cytogenetical details of some intergeneric hybrids

INTERGENERIC HYBRID	SOMATIC COUNT	MEIOTIC RELATIONSHIP
Barley x 6x wheat v. Bonza	28	23.9_{I} 1.4_{II} $0.5_{II(.)}$* 0.1_{III} 0.03_{IV} 0.01_{VI}
Barley x 6x wheat v. Pavon	28	24.6_{I} 1.3_{II} $0.5_{II(.)}$* 0.1_{III} 0.03_{IV}
Barley x 6x wheat v. Chinese Spring	28	23.9_{I} 1.4_{II} $0.2_{II(.)}$* 0.3_{III} 0.1_{IV}
6x wheat x E. giganteus	35	32.8_{I} 1.02_{II}
Barley x Elymus	28	19.6_{I} 2.6_{II} $0.004_{II(.)}$* 0.8_{III} 0.14_{IV}
E. canadensis x Barley	21	Three hybrids, all vegetative

* Closed or ring bivalents

(2n=4x=28, HABD)

The barley x T. aestivum hybrids (cv. Bonza, Pavon and Chinese Spring) had a mean chromosome pairing relationship of 24.3_{I} 1.33_{II} $0.38_{II}(.)$ 0.15_{III} 0.028_{IV} 0.033_{VI} with a mean chiasmata frequency of 2.57 per cell. Heteromorphic bivalents were frequently present. These observations indicate homoeologous chromosome pairing. The heteromorphic bivalents suggest a possible association of the barley and wheat chromosomes, a view earlier expressed by FEDAK 1977. The latter provides a recognizable means of genetic transfer between barley and wheat. The hybrids were phenotypically wheat-like, a dominant expression of the higher polyploid level of wheat.

T. AESTIVUM (2n=6x=42, AABBDD) x E. GIGANTEUS (2n=4x=28, JJXX) hybrid (2n=5x=35, ABDJX)

In the T. aestivum x E giganteus hybrid, the biparental phenotype was expressed. The mean meiotic relationship of 32.8_{I} 1.02_{II}, suggested a maintenance of genome specificity in that the extent of 1.02 rod bivalent frequency was close to the pairing in T. aestivum polyhaploids (2n=3x=21, ABD).

H. VULGARE (2n=14, HH) x ELYMUS (2n=6x=42, $S_2S_2H_2H_2H_3H_3$) hybrid (2n=4x=28, $HS_2H_2H_3$)

Paternal dominance was expressed in the barley x Elymus hybrid. The chromosome pairing indicates a modification of relationships in the HH_2H_3 genomes because of (i) consistent occurrance of heteromorphic bivalents and (ii) presence of a high frequency of rod bivalents as opposed to ring bivalents, or trivalent associations.

BACKCROSS PROGENIES

Meiocytes were frequently observed in the meiotic analysis of barley x T. aestivum, and T. aestivum x E. giganteus hybrids with chromosomal separations tending towards meiotic non-reduction. The frequency of such meiocytes from low to high ranged as:

T. aestivum cv. Chinese Spring x E. giganteus $<$ Barley cv. Manker x Bonza Barley x Pavon $<$ Barley x Chinese Spring.

The sterile hybrids were backcrossed to both the male and female parents. Seed set was obtained in all cases for the barley x T. aestivum with respective wheat parents, and for T. aestivum x E. giganteus with T. aestivum. Gibberellic acid at 75 ppm enhanced seed set when applied twice as a post-pollination treatment, Table III). Some barley x T. aestivum x T. aestivum BC seed have somatically been confirmed to possess 49 chromosomes (2n=7x=49, AABBDDH). The heptaploid progeny may produce (i) Modified T. aestivum euploids, (ii) Disomic barley addition lines and (iii) Disomic barley substitution lines. It remains to be seen whether pistilloidy (ISLAM et al. 1975) will complicate obtaining BC_2 progeny. The T. aestivum x E. giganteus x T. aestivum BC seed have germinated and are identified somatically to be 2n=8x=56, AABBDDJX.

B. Plants maintaining only the maternal chromosome complement are fertile, and cytogenetically normal euploids

TABLE III. Intergeneric hybrids and backcross data

Laboratory No.	Intergeneric F_1 hybrids						Backcross Parent	
	Genera	Variety		Genera	Variety			
79-1117A	H. vulgare	Manker	x	T. aestivum	Pavon	x	Pavon	
1117B	"	"	x	"	Pavon	x	Pavon	
1120A	"	"	x	"	Pavon	x	Pavon	*
1120C	"	"	x	"	Pavon	x	Pavon	*
1121	"	"	x	"	Pavon	x	Pavon	*
1120B	"	"	x	"	Pavon	x	Pavon	*
1123	"	"	x	"	Bonza	x	Bonza	*
1118	"	"	x	"	C. Spring	x	C. Spring	
1124C	"	"	x	"	"	x	"	
1124B	"	"	x	"	"	x	"	*
1125B	"	"	x	"	"	x	"	*
1124D	"	"	x	"	"	x	"	*
1125C	"	"	x	"	"	x	"	*
1124A	"	"	x	"	"	x	"	*
1125E	"	"	x	"	"	x	"	*
1125A	"	"	x	"	"	x	"	*
1125D	"	"	x	"	"	x	"	*
1125F	"	"	x	"	"	x	"	*
1126	T. aestivum	C. Spring	x	E. giganteus		x	"	*

* Denotes that two post-pollination applications of GA_3 were applied at 75 ppm

Any mechanism that can generate euploid plants from intergeneric crosses still needs to be practically clarified, since the possibility exists for confounding results by outcrossing, mutations via chemicals or embryo-culture media, or cell development from the megasporophytic tissue. All these phenomena occur in low frequency, and have the potential to generate cytologically normal but segregating euploids, (Mujeeb et al. 1978).

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Received 7th May 1980