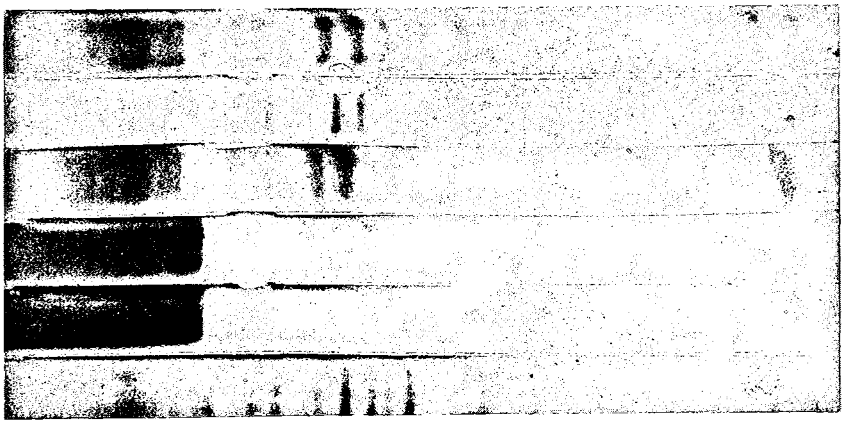
WHEAT INFORMATION SERVICE



No. 17, 18

March 1964

Wheat Information Service
Biological Laboratory, Kyoto University
Kyoto, Japan

CONTENTS

I. Research Notes

No. 17 WIS March 1964

I. RESEARCH NOTES

Analysis of cross-pollination in *durum* wheat

A. Bozzini, F. d'Amato, L. M. Monti and G. T. Scarascia Mugnozza
Laboratorio per le Applicazioni in Agricoltura, C. N. E. N., Roma
and Istituto di Genetica della Universita, Pisa, Italy

In order to test the frequency of outcrossing in *durum* wheat plants raised from both irradiated and unirradiated seeds, four trials were conducted during two years in the experimental fields of the " Comitato Nazionale per l'Energia Nucleare " at the Casaccia (Roma, Italy). Two recessive *clorina* (yellow green) mutants of " Cappelli " were used as genetic markers (R_4/172 and R_4/188).

Each of the four trials consisted of three plots, in each of which seeds of *chlorina* and of the mother line Cappelli (green) were sown in 21 alternate rows (150 seeds per row) in such a way as to have every one of the *chlorina* rows flanked, on both sides, by Cappelli rows. For one of the three plots, unirradiated *chlorina* seeds were used; for the remaining two, *chlorina* seeds irradiated with 9 Kr and 18 Kr of X-rays respectively were sown. The seeds were irradiated at 250 KV, 15 mA, 1425 r/min after being equilibrated at 9 % water content. All *chlorina* plants in each plot were harvested separately and their spikes were analyzed in the greenhouse for occurence of green seedling, assumedly resulting from cross-pollination with Cappelli.

Outcrossing frequency was calculated on both a spike and a seedling basis. In unirradiated materials in the four trials the frequency of spikes with outcrossing events was between 4.96 % and 28.89 %, and the frequency of green seedlings between 1.8 ‰ and 17.6 ‰ (outcrossing).

An increase over control in the frequency of outcross seedlings was ascertained in the material irradiated with 18 Kr of X-rays, whilst no difference was ascertained between the control and the 9 Kr series.

The frequency of outcrossing events in the central portion of each plot was found to be higher than in the peripheral portion, probably because of higher pollen concentration in the center of the plot. Moreover, increase in outcrossing frequency in irradiated material apparently resulted from the reduction in spike fertility induced by irradiation: in the 18 Kr series, the frequency of spikes showing a spike fertility lower than 50% was 18.18 as opposed to 8.26% in the control.

Reversion of *chlorina* to green in the two mutants used is rather low, as ascertained by an analysis of *chlorina* spikes prevented from undergoing cross pollination by bagging.

If it is assumed that the frequency of cross-pollination between *chlorina* plants (which cannot be determined with the present experimental design) is either identical or comparable to that of the outcrossings *chlorina* × green, the real outcrossing figures in our material are twice or nearly twice those reported.

That outcrossing in *durum* wheat is of normal occurence in the environmental conditions of the Casaccia experimental fields is shown by the cases of cross-pollinations found in our collection of induced mutants. In a total of 223 true-breeding M_3 mutant progenies, 34 (15.2%) showed evidence of outcrossing, the frequency of individuals derived from cross-pollination being 9.62%.

It is concluded that careful control of pollination in *Triticum durum* is necessary both in pure line maintenance and in experiments with mutagenic agents.

A detailed paper on the subject will be published in "Genetica Agraria", Pavia.

Viable mutations in *durum* wheat induced by radiations and chemicals

F. D'AMATO, G. T. SCARASCIA MUGNOZZA and A. BOZZINI
Istituto di Genetica dell'Università, Pisa and Laboratorio per le Applicazioni in Agricoltura,
C. N. E. N., Roma, Italy

Since 1956, experiments were carried out on the induction of mutations in *durum* wheat (varieties: Aziziah, Cappelli, Russello) by X-rays, fast neutrons, thermal neutrons, ethylmethanesulphonate, diethylsulfate and ethyleneimine. So far 396 independently obtained cases of viable mutations have been isolated; moreover, several hundreds of lethals are being maintained as heterozygotes.

As shown in the accompanying table, the 395 mutations available involve either single or several characters (complex phenotypes); they constitute a valuable material for both theoretical and applied research.

Among the mutations listed, the following three appear to be of an evolutionary interest, namely:

1) "vavilovoid", characterized by an increased number of nodes and strong elongation of the internodes in the rachilla, heading to a pseudo-branched spike; this character, resembling the pseudo-branched spike of the hexaploid *Triticum vavilovii,* behaves as a simple recessive;

2) "supernumerary spikelets" (*elymoides*), showing 3 to 7 spikelets on each rachis node instead of one, as normally in *Triticum.* Also this character behaves as a simple recessive;

3) "solid stem", characterized by pith-filled culms; this mutation, showing a semi-dominant type of inheritance, is regarded to result from a deletion of the gene Mb for hollow stem, which is epistatic, only when homozygous, on one or more genes inducing stem solidness (Bozzini and Avanzi, 1962 Caryologia, 15: 525-535).

As to mutations of possible agronomic value, good promise seems to offer mutations for short straw, higher lodging resistance, increased spike and spikelet fertility.

Large-scale field trials for an agronomic evaluation of some of the induced mutants have been greatly facilitated by the establishment, in 1960, of a Research Group on *durum* wheat under the sponsorship of the Italian Research Council. The group includes, besides our Laboratories, the following Institutes: Institute of Cereal Genetics of the Ministry of Agriculture, Rome; Institute of Plant Pathology of the University, Bari and the Institutes of Agronomy of the Universities of Bari, Palermo and Sassari. The field trials conducted in the last three seasons in several localities of the Southern and Central Italian peninsula, in Sicily and Sardinia have shown that some mutants manifested a good performance in most trials, reaching in some of them significantly higher yields than those of the mother line (Cappelli).

The genetic and cytological analyses carried out so far on the mutant collection have shown that:

1) in a total of 51 mutations studied, 41 behaved as monogenic recessive, 2 as semidominant and the remaining 10 showed segregation ratios lower, or much lower, than 25%, in connection with different sterility degrees;

2) analysis of meiosis in M_3 and M_4 mutant progenies as well as in the F_1 of the cross "mutant × mother line" revealed the occurence of a reciprocal translocation in 25 out of 52 mutations investigated (MARTINI, Genetica Agraria, in press).

Our work on experimental mutagenesis and on the cytogenetics of induced mutations in *durum* wheat is being continued.

Table 1. Types and numbers of viable mutations for individual and complex characters in *durum* wheat induced by radiations and chemicals

Mutation types	Total number of mutations	Mutations induced		
		X	N	C
Tigrina	34	2	21	11
Viridis	22	-	17	5
Chlorina	19	2	10	7
Virescens	24	3	13	8
Dark green	1	1	-	-
Prostrate tillering	3	1	2	-
Short leaf	1	1	-	-
Anthocyanic leaf	22	2	14	6
Narrow leaf	2	-	2	-
Increased length of last internode	3	-	1	2
Solid stem	2	2	-	-
Waxless	12	4	8	-
Compact ear	14	3	7	4
Squarehead	1	-	1	-
Cylindric ear	3	2	-	1
Lax ear	50	1	21	28

Table 1. continued

Mutation types	Total number of mutations	Mutations induced		
		X	N	C
Short ear	5	-	3	2
Anthocyanic awns and glumes	6	1	4	1
Awned glumes	2	1	-	1
Falcate caryopsis	1	-	1	-
Defective endosperm	1	1	-	-
Dwarf, late, malesterile	4	-	3	1
Dwarf, twisted culm and leaf	2	1	1	-
Dwarf, long ear, narrow leaf	1	-	-	1
Vavilovoid	8	2	5	1
Brachytic, compact ear	6	1	4	1
Brachytic, twisted ear	3	1	2	1
Elymoides	2	-	1	1
Short straw	53	-	40	13
Short straw, narrow leaf	11	4	7	-
Short straw, compact ear	19	2	11	6
Short straw, lax ear	20	-	11	9
Short straw, narrow leaf, lax ear	1	-	1	-
Short straw, lax ear, awned glume	15	-	14	1
Tall, small glume and seed	1	-	1	-
Tall, elongated ear	1	-	-	1
Tall, lax ear	1	-	-	1
Compact ear, narrow leaf	1	1	-	-
Compact ear, awned glume	8	-	3	5
Lax ear, awned glume	10	2	-	8
Total	395	41	41	125

X = X-rays; N = Neutrons; C = Chemicals

A true breeding grass clump dwarf wheat

L. E. Evans
Plant Science Department, University of Manitoba, Wpg., Canada

In an earlier report Canvin and Evans (1963) reported near by normal growth and seed production in F_1 grass clump dwarf wheat plants grown continuously at 26.5°C.

One of the crosses so treated was Marquillo × Kenya Farmer. The F_1 and F_2 generations from this cross were grown at 26.5°C and all plants elongated and reproduced. A total of 99 F_3 lines were grown in the field in the summer of 1963. Of these, three produced only grass clump dwarfs. Plants from these lines were transplanted to a growth chamber at 26.5 °C where several elongated and set seed. F_4 and F_5 lines have since been grown and have shown no segregation indicating that a homozygous line of grass clump dwarfs requiring high temperature for reproduction has been produced.

Semi-dwarf, normal and winter habit plants have also been recovered from this cross. The inheritance aspects are presently under investigation.

Influence of planting date on some agronomic characters of wheat

I. Influence on period till heading

Hosni A. Mohamed
Bahtim Experiment Station, Cairo; U. A. R.

Nine wheat varieties of different origin and genetic constitution were selected for this study. The work was originally designed to study the influence of planting date on rust reaction. Agronomic characters were also considered and will be given in parts.

Varieties of wheat used in this study were the commercial wheats Tosson, Giza 139, Giza 144, and Giza 145 and the imported wheats Ramona and Montana, which are used in our stations mostly as spreaders for stem rust;

all these varieties belong to *Triticum vulgare*. The commercial *durums* Baladi Bahtim and Baladi 116 and also *Triticum timophevii* represented the tetraploid group. Germination of *T. timophevii* seed was poor. Also this line did not head in most plantings.

Wheat varieties were planted at Alexandria (in the northern part of the U. A. R.) and at Bahtim near Cairo (in the central part of the U. A. R.). Planting was each 20 days in 8 dates of planting at Alexandria and 13 dates of planting at Bahtim, starting September 22 at Alexandria and September 20 at Bahtim.

Notes on heading were recorded considering 50% heading at Alexandria and first heading at Bahtim. Period was considered from planting date as seed were irrigated immediately after planting. On the other hand, it would be harder if period was calculated on the basis of germination. On this basis the period till heading was considered as from planting date. Temperature was obtained for both Alexandria and Bahtim and showed a decrease in maximum and minimum temperatures followed by an increase thereafter, which resembles the trend of the period till heading for most varieties.

In general, results (Table 1) can be summarized as follows:

1. Varieties differ in the period till heading but they agreed in the fact that the period for each variety increased then decreased thereafter. *Triticum timophevii* did not head in all plantings except at Bahtim in the September 20 planting after 194 days from planting.

2. Comparing the period till heading in the different planting dates for each variety, the period was the longest at Alexendria in the October 12 planting for the varieties Baladi 116 and Baladi Bahtim, the two tetraploids, and November 1 for the variety Montana and November 21 planting for the varieties Tosson, Giza 139, Giza 144, Giza 145 and Ramona. At Bahtim the longest period was in the October 10 planting for the varieties Giza 145 and Baladi Bahtim and October 30 for the varieties Tosson, Giza 139, Giza 144, Montana, Ramona and Baladi 116.

Table 1. Period till heading of 8 wheat varieties planted at Bahtim and Alexandria in different dates of planting

Date of planting		Period till heading for :							
		Tosson	Giza 139	Giza 144	Giza 145	Ramona	Montana	B.B.	B. 116
at Bahtim :									
Sept.	20	66	69	85	84	54	77	101	121
Oct.	10	93	92	103	102	58	94	116	125
Oct.	30	96	98	104	99	87	102	119	122
Nov.	19	95	92	95	95	85	99	107	104
Dec.	9	86	86	89	87	84	88	94	88
Dec.	29	78	77	81	80	76	87	87	87
Jan.	30	64	64	68	68	60	72	73	72
Feb.	12	67	65	67	66	59	68	73	68
March	3	57	54	63	59	51	63	67	65
March	23	49	49	49	49	43	54	55	55
April	12	43	44	43	44	42	53	55	55
May	2	38	38	38	40	40	40	40	40
May	22	--	--	--	43	37	--	--	--
at Alexandria :									
Sept.	22	56	64	64	56	47	64	116	112
Oct.	12	93	86	86	74	64	82	127	147
Nov.	1	100	96	99	98	66	104	121	121
Nov.	21	102	102	107	107	84	102	120	120
Dec.	11	85	85	91	89	76	90	95	92
Dec.	31	85	82	82	80	75	77	100	100
Jan.	20	80	74	76	78	65	72	86	80
Feb.	10	85	65	73	--	49	69	73	69

Influence of planting date on some agronomic characters of wheat

II. Influence on yield

Hosni A. Mohamed
Bahtim Experiment Station, Cairo; U. A. R.

Plots were replicated 4 times at Bahtim, and yield was obtained for the October 30, November 19, December 9, and December 29 plantings. In these plantings, there was no damage by birds and also plant stand was almost complete. Yield of seed at the end of the season was weighed and results were analyzed statistically; average yield from the 4 replicates given in the accompanying table.

Yield of seed for each date of planting was singly analyzed, and statistical analyses showed that differences between varieties were statistically significant only in the case of the October 30 planting. Least significant differences were 0.316 Kg and 0.430 Kg at 0.05 and 0.01, respectively. Combined analyses between the 4 dates of planting showed that differences between varieties and between dates of planting were highly significant. Interaction between varieties and dates of plantings were not statistically significant. Least significant differences, in case of varieties were 0.180 Kg and 0.239 Kg at 0.05 and 0.01, respectively and 0.128 Kg and 0.170 Kg at 0.05 and 0.01, respectively, in case of planting dates.

Table 1. Average yield in Kilograms of 8 wheat varieties planted at Bahtim in 4 different dates of planting

Wheat variety	Average yield in Kg when planted on:			
	Oct. 30	Nov. 19	Dec. 9	Dec. 29
Tosson	1.139 Kg	1.500 Kg	1.115 Kg	.650 Kg
Giza 139	.930	1.130	.953	.488
Giza 144	1.071	1.140	.639	.393
Giza 145	1.092	1.260	.775	.518
Ramona	.428	.723	.631	.460
Montana	.626	.943	.870	.513
Baladi 116	.606	.898	.768	.455
Baladi Bahtim	.787	1.145	.700	.575

Homoeologous chromosome recombination in *Triticum aestivum*

C. N. LAW
Plant Breeding Institute, Cambridge, England

The absence chromosome 5B in *Triticum aestivum* results in non-homologous pairing and recombination (RILEY 1960). Evidence is also available which indicates that non-homologous exchanges are confined largely to chromosomes within, rather than between, the seven homoeologous groups of *T. aestivum* (RILEY and KEMPANNA 1963). These two facts imply that, by the use of suitable chromosome techniques, strictly homologous recombination can be extended so as to involve the, presumably, genetically more diverse homoeologues. It has been suggested by RILEY (1960) that the application of such techniques may allow a repatterning of the genetic architecture of wheat in ways which may be economically beneficial. Thus, it may be envisaged that the duplication or the removel of certain genes or regions of a chromosome may improve the genetical behaviour of wheat in a desired way. Indeed, this method of plant breeding is already being attempted in *Hordeum vulgare.* (HAGBERG, PERSSON and WIBERG 1963).

As a first step in exploiting this approach it is necessary to demonstrate that variation as a result of homoeologous recombination can be achieved from within a pure breeding line of hexaploid wheat. An experiment was consequently undertaken in which material, deficient for chromosome 5B and tetrasomic for chromosome 5D, in the variety Chinese Spring (obtained from Dr. E. R. SEARS) was multiplied so that sufficient seed for a small field experiment was available. Moreover, of obvious importance to this experiment, a number of generations have elapsed since the nullisomic-tetrasomic material was first formed, so that the results of homoeologous recombination may reasonably be expected to have appeared.

Progenies from twelve plants taken at random amongst the stock material were studied. To eliminate changes in chromosome number, root-tip counts were carried out on each plant. Where departures from $2n = 42$ occurred, the deviant plants were discarded. As a result observations were confined to plants having the hexaploid number of chromosomes only. The layout of the experiment consisted of two randomised blocks in which each plot contained five plants, spaced twelve inches apart. Measurements were made on each plant and the mean effects taken over blocks and plots are shown in the accompanying table 1. Analysis was carried out on the mean effect of the five plants per plot.

Clearly, differences between the families occurred for the three characters studied and were highly significant in the case of the number of grains per ear. Correlation coefficients between the characters demonstrate that there is some evidence that height and the number of ears per plant are controlled either by the same genes or by associations of dissimilar genes due to linkage. This follows from the significant correlation coefficient for these two characters $r = 0.8552 \pm 0.1636$, $P = \langle 0.001$. There is no evidence for a correlation of either of these two characters with the number of grains per ear. Certain qualitative differences were also apparent, in particular, the shapes of the ears varied considerably, so that some families were extremely compactoid, whereas in others a more extended spike was observed,

It is possible that some of the differences observed may reflect whole chromosome changes which resulted from non - disjunctional behaviour or from compensatory chromosomal changes associated with the nulli - 5B genotype. The wide range of variation observed, however, suggests that such possibilities are unlikely to be the main source of segregation and that the more probable cause of most of the variation is homoeologous recombination.

The initial pre - requisite, namely, that of available variation, would appear to be satisfied by the results described here. Further requirements are, however, obviously necessary before techniques of this nature can be used in plant breeding. Thus two questions, which are vital to the success of the method have still to be tested and answered. The first concerns the problem of stabilizing the genotype of a desired phenotype either by the re - introduction of chromosome 5B or by alternative genetic means. The second involves the question of whether an economic improvement, by alterations within a genetic system that is already finely adjusted, can be achieved by drastic measures of this kind. In this connection it is of interest to recall that the often quoted advantage of inbreeding with allopolyploidy is that it allows heterozygosity to be fixed. The recombination produced by the use of nulli-5B techniques, could destroy the advantages of any homoeologous heterozygosity which may exist within the wheat genotype. If this is so, improvements in economic fitness will be difficult to achieve. On the other hand, a better understanding of the genetic architecture of wheat, a subject which at present requires some refinement, may demonstrate that such difficulties may not arise and new levels of genetic balance within hexaploid wheat may be possible.

Table 1. Measurements, presented as the average over plots and blocks, for twelve families derived from a nulli 5B tetra 5D population

Family Number	Height in Centimetres	Number of Ears per plant	Number of Grains per ear
1	66.03	5.90	9.79
2	63.50	7.00	13.12
3	64.60	6.80	11.50
4	62.20	4.50	19.51
5	51.03	3.53	7.71
6	53.60	5.80	6.87
7	53.00	3.30	8.07
8	50.10	2.80	2.73
9	54.90	4.80	8.32
10	68.90	9.90	9.93
11	65.60	7.50	14.74
12	65.63	8.75	11.93
Family M.S. n = 11	92.95*	9.80**	36.69***
Error M.S. n = 11	27.20	2.08	5.10

* 0.05 - 0.01 ** 0.01 - 0.001 *** < 0.001

The effect of the deficiency of the long arm of chromosome 5B on meiotic pairing in *Triticum aestivum*

R. Riley and V. Chapman
Plant Breeding Institute, Cambridge, England

The original hypothesis of Riley and Chapman (1958) and of Sears and Okamoto (1958), that the deficiency of chromosome 5B from the chromosome complement of *Triticum aestivum* results in the meiotic pairing of homoeologous as well as of homologous chromosomes, has now been confirmed (RILEY and KEMPANNA 1963). At the time of the first investigation of the activity of this chromosome, in 20-chromosome nullisomic-5B haploids, evidence was available from 21-chromosome haploids carrying the long arm of 5B as an isochromosome that this arm was independently capable of preventing homoeologous pairing. This was confirmed by observation of the entirely homologous pairing behaviour of 41- and 42-chromosome plants respectively monotelocentric and ditelocentric for the long arm but deficient for the short arm.

However, it was difficult to ascertain whether the short arm produced any effect on homoeologous association since plants of *T. aestivum* that carried the short but lacked the long arm could not be obtained. This obstacle arose because although the telocentric for the short arm had been isolated it could only be maintained in combination with a complete chromosome. When a plant with one complete and one short telocentric chromosome 5B was self-pollinated the progeny obtained never contained individuals in which the short telocentric was disomic, presumably due to certation. Ultimately by crossing a range of forms of *T. aestivum*, that had different conditions of 5B, with *Aegilops cylidrica*, hybrids were obtained that were either deficient for the complete chromosome, or for its long or short arm separately, or in which the complete chromosome was present (RILEY 1960). The meiotic behaviour of hybrids carrying the short arm telocentric was similar to that of those lacking the complete chromosome, whereas the behavior of the hybrids carrying the long arm telocentric resembled that of the euploid hybrids. Consequently it was reasonable to conclude that the activity that resulted in the suppression of homoeologous affinity was confined to the long arm alone.

However, in an attempt to check this result work was continued with plants of *T. aestivum* Holdfast with various telocentric conditions of chromosome 5B. In the course of this investigation 42-chromosome plants with one complete and one short arm telocentric 5B were pollinated with the pollen of individuals ditelocentric for the long arm telocentric. Amongst the F_1 generation of this cross there were plants with 42 chromosomes in which 5B was represented as one long arm and one short arm telocentric. At meiosis both telocentrics were univalents and they were transmitted irregularly to the progeny of the doubly telocentric F_1 plants. Table 1 shows the numbers of plants with various chromosome constitutions, as determined at meiosis, that were obtained in these progenies.

Table 1. The chromosome numbers and constitutions of the progeny of plants in which chromosome 5B was represented by one long and one short telocentric

Chromosome number	Constitution and status of 5B	Number of plants
20	nulli.-5B haploid	1
21	short 5B telocentric haploid	1
40	nullisomic 5B	1
41	mono. long telocentric	14
41	mono. short telocentric	2
42	mono. short telocentric and mono. long telocentric	65
42	diso. short telocentric	1
43	mono. short telocentric and diso. long telocentric	7
43	mono. long telocentric and diso. short telocentric	13
	Total	105

It will be seen that for the first time it has been possible to obtain plants that were monosomic or disomic for the short telocentric of 5B and at the same time deficient for the long arm. One objective of this exercise was to ascertain whether the sterility of the nullisomic could be circumvented by including the short arm alone, and this proved to be so since these plants were weakly fertile on selfing. Moreover the plants, monosomic and disomic for the short arm, were also multivalent-forming-presumably due to homoeologous pairing. Their employment may consequently facilitate the use of homoeologous recombination in breeding investigations. Multivalent frequency was essentially similar to that in plants nullisomic for 5B, with trivalents or quadrivalents and rarely higher associations between 20 per cent and 40 per cent of cells. No plant carrying the long arm showed similar multivalents.

While it is clear from this that the short arm produces no effect in restraining homoeologous pairing, its lack of influence was most clearly displayed in the behaviour of the 21-chromosome haploid that carried the short telocentric. This plant had many bivalents and trivalents, like 20-chromosome nullisomic-5B haploids, and the telocentric was paired in eight per cent of cells. The mean meiotic pairing behaviour of this plant has been compared with earlier haploid data in Table 2. From this the close similarity of its meiosis to that of haploids deficient for chomosome 5B can be clearly seen. This evidence must, therefore, be regarded as unequivocal confirmation that the effect of chromosome 5B in suppressing homoeologous pairing is wholly due to the activity of the long arm and that the short arm produces neither a direct effect nor any influence stemming from interaction with the long arm.

Table 2. Mean pairing at first metaphase of meiosis in haploids with various conditions of chromosome 5B

Haploid type	Chrom. number	5B long arm	5B short arm	Cells	Mean pairing			
					Univ.	Biv.	Triv.	Quad.
euhaploid	21	present	present	750	18.84	1.05	0.02	-
long arm 5B iso.	21	present	absent	100	19.20	0.90	-	-
mulli. - 5B	20	absent	absent	218	7.42	3.72	1.62	0.07
short arm 5B telo.	21	absent	present	50	6.62	3.82	2.22	0.02

Haploid *Aegilops caudata*

V. CHAPMAN and R. RILEY
Plant Breeding Institute, Cambridge, England

Only two haploid plants have previously been reported in the genus *Aegilops.* These were in the species *Ae. ovata* (2n = 28) and *Ae. longissima* (2n = 14) and both occurred in progenies resulting from pollination of the *Aegilops* forms with the pollen of *Triticum* species. The instance reported here is concerned with a haploid individual of *Ae. caudata* (2 = 14).

In a population of *Ae. caudata* grown in the field at Cambridge one plant had gaping glumes and non-dehiscent anthers at flowering. Cytological preparations were made from root-tip and anther squashes and these showed the plant to have only seven chromosomes and therefore to be haploid.

At first metaphase of meiosis all the chromosomes were univalents in most cells, but one bivalent was occasionally formed (Table 1). The low frequency of bivalents is similar to those reported in haploids of other diploid species in *Aegilops* and *Triticum* and it can be interpreted to mean that there is little duplication of genetic material within the genome of *Ae. caudata.* This information may be of value to those concerned with the interpretation of meiotic chromosome pairing, in hybrids involving *Ae. caudata,* in genome analysis and evolutionary studies.

Table 1. Chromosome behaviour at first metaphase of meiosis

Pairing behaviour	Number of cells
7 univalents	243
1 biv. 5 univ.	7
Total	250

On the intraspecific variability of baking quality components in Einkorn-wheats, *Aegilops speltoides* and *Aegilops squarrosa*

D. Mettin
Institut fuer Pfanzenzuechtung
der Martin - Luther - Universitaet Halle - Wittenberg
Hohenthurm b. Halle/S., Germany (DDR)

Much work has been done on the variability, genetics, and chemical nature of baking quality in the bread wheats. But there are not so many investigations concerning with the single components of quality and their variability in the possible contributors to hexaploid wheats. It is supposed that the introgression of *Ae. squarrosa* has raised the protein and accordingly the gluten content of the common wheat. One can suppose that the quality of the existing bread wheats is primary due either to the combination of contributors with different quality components or has originated by mutation on the tetraploid or hexaploid level.

As part of a more comprehensive program we have carried out some investigations on the variability of baking quality factors in the following species : *T. boeoticum*, *T. monococcum*, *Ae. speltoides* (as the possible contributor of genome B), and *Ae. squarrosa*. The investigations were extended to the following characters, mainly used here for hexaploid wheats : Protein content of air-dried material (after Kjeldahl method), gluten quality (Testzahl by Schrotgaermethode after Pelshenke, and Quellzahl after Berliner & Koopmann), and wet gluten content. The judgement of baking quality by these indirect methods has revealed a sufficient agreement with standard- and microbaking tests in the hexaploid wheats.

The results are summarized in table 1 listed below. We used for control the hexaploid wheat variety " Hadmerslebener Qualitas " with good quality under our conditions. In general our results confirm the findings of other workers that there is a close correlation between protein and gluten content. But there are considerable differences in gluten resp. protein content between the species. The high gluten contents especially of the two *Aegilops* species agree very well with the findings of Yamashita et al. (1956). In spite of the low number of strains in *T. boeoticum* there seem to be considerable differences in gluten resp. protein content between the two diploid wheats. The intraspecific variability of these two characters mentioned being the least in *T.*

Table 1. Mean values and range of baking quality components in *T. boeoticum*, *T. monococcum*, *Ae. speltoides*, and *Ae. squarrosa*

	Triticum boeoticum	*Triticum monococcum*	*Aegilops speltoides*	*Aegilops squarrosa*	Control
Number of strains investigated	4	20	2	6	1
Protein content in %					
mean value of all strains	25.1	20.3	25.6	22.8	14.0
range	24.7 - 25.4	17.9 - 23.3	24.7 - 26.5	19.5 - 26.8	
Wet gluten content in %					
mean vrlue of all strains	43.3	31.9	61.0	49.7	21.3
range	40.3 - 46.1	14.9 - 44.1	56.1 - 65.9	44.4 - 58.9	
Gluten quality (after Testzahl)					
mean value of all strains	59	53	69	68	62
range	43 - 71	39 - 68	66 - 71	29 - 105	
Gluten quality (after Quellzahl)					
mean value of all strains	0.4	0.5	0.6	0.8	7.75
range	0.0 - 1.0	0.0 - 1.5	0.5 - 0.8	0.0 - 2.5	

boeoticum and much higher in *T. monococcum*. Nevertheless all strains investigated exceeded the control variety to a considerable amount. The evaluation of gluten quality showed some differences depending on the method used. There are no differences in mean values for the species, when Testzahlindex is applied. The variability of this character seems to be low with the exception of *Ae. squarrosa.* Gluten quality measured by Quellzahlen yielded lower values in general. The variability is however about the same. While there is a good agreement of Testzahlen between the control variety and the four species investigated, the use of Quellzahlen seems doubtful in our experiments.

A polyhaploid plant of *Agropyron tsukushiense* var. *transiens* Ohwi found in a state of nature

S. SAKAMOTO
National Institute of Genetics, Misima, Japan

A. tsukushiense var. *transiens,* a common weed growing in fields and along road-sides, is widely distributed in Japan, China, Manchuria and Korea. This species is hexaploid ($2n = 42$).

In a valley of the hilly neighborhood of Misima, a spontaneous polyhaploid plant ($2n=21$) of the species was found. It was smaller than the hexaploid specimens of the species and had slender spikes, but its tillering was very vigorous. In natural condition it yielded two seeds which were assumed to have been produced by pollination with the pollen of hexaploid plants growing in its proximity. The two seeds gave two plants, one a disomic ($2n = 42$) and the other a monsomic ($2n = 41$).

Pollen fertility of the polyhaploid, the monosomic and the disomic was 0.001, 28.5 and 78.5% and seed fertility was 0, 53.3 and 76.6%, respectively. The polyhaploid was crossed by the disomic and by two *A. tsukushiense* var. *transiens* strains, and the crossing success amounted to 1.0 1.6%.

Chromosome pairing at MI of PMCs of the polyhaploid and the monosomic is shown in Table 1. Of 442 cells observed in the polyhaploid, in 83% 21_{I} and in 14% 1_{II} (terminal pairing) + 19_{I} were observed. In the majority of cells chromosome pairing in the monosomic was $20_{\mathrm{II}} + 1_{\mathrm{I}}$. This result indicates that *A. tsukushiense* var. *transiens* is an allohexaploid whose genome constitution comparises three different genomes.

Table 1. Chromosome pairing at MI of PMC's of the polyhaploid and a monosomic of *A. tsukushiense* var. *transiens*

Polyhaploid	No. of cells observed	%
21_{I}	369	83.5
$1_{II} + 19_{I}$	61	13.8
$1_{III} + 18_{I}$	2	0.5
$2_{II} + 17_{I}$	8	1.8
$1_{IV} + 17_{I}$	1	0.2
$2_{II} + 51_{I}$	1	0.2
Total	442	100.0
Monosomic:		
$20_{II} + 1_{I}$	164	97.0
$19_{II} + 3_{I}$	5	3.0
Total	169	100.0

Determination of wheat flour proteins by gel electrophoresis

John M. LAWRENCE and D. R. GRANT
Department of Agricultural Chemistry, Washington Agricultural Experiment Stations,
Washington State University, Pullman, Wash., U. S. A.

Many of the differences in the quality of wheat varieties for various food purposes have been suggested to be due to more or less subtle differences in the proportions of individual proteins in the flour (1). Clearly the effort to breed wheat for quality would be much advanced by expeditious methods for quantitative determination of the proteins. Among the newer methods for protein separations, zone electrophoresis in starch gels (2,3) and polyacrylamide gels (4,5) have shown the most resolving power, but their application to quantitative analytical procedures has not been extensively studied.

The present method makes use of an aluminium lactate buffer extract of flour (pH 3.2, ionic strength 0.1). A single thorough extraction followed by ultracentrifugation yields a clear extract which contains 50 to 80% of the flour proteins. Polyacrylamide gels were used in a specially designed apparatus such that electrophoresis occurs in a vertical orientation in individual water-cooled strips for each sample. The sample volumes introduced into slots in the gels are accurately measured. The gels are cast in water with or without urea. (Urea improves the resolution, but causes minor changes in the pattern). Aluminium lactate buffer is then introduced to the gel by overnight electrophoretic equilibration. A two-hour electrophoresis of the sample spreads the pattern well throughout the length of the gel strip, though a longer run provides better separation of the predominant slower-moving proteins. The proteins are stained with amido black dye, and the absorbance of the bands is determined by passing the strip through a Photovolt densitometer. The true protein content of individual bands (or groups of bands) is calculated by multiplying the peak areas by correction factors for the dye-binding capacities of the proteins. These were determined by cutting out the bands from the gels, hydrolyzing, and analyzing for the total amino nitrogen content as a measure of the true protein concentration. It was found that the slower moving proteins generally bind less dye than the faster ones. The two fastest bands in particular represent very little protein.

As many as 30 different bands have been detected on such gel strips, though many of these are not sufficiently resolved for separate quantitative determination. Generally about eight different groups of bands have been determined. Quantitative differences have been found in the relative protein make-up of different market classes of wheat. Figure 1 shows some striking differences among some varieties tested. Differences between air-classification fractions which had not been revealed by previous studies (6), were shown by this method.

This work was largely supported by a contract with the U.S. Department of Agriculture, authorized by the Research and Marketing Act of 1946, and supervised by the Western Utilization Research and Development Division

---

* Present address: Department of Chemistry, University of Saskatchewan, Saskatoon, Saskatchewan, Canada

of the Agricultural Research Service. The authors wish to express their appreciation to Mr. N. K. Patni and Mrs. Hedwig Herrick for technical assistance, and to Dr. C. F. Konzak and Mr. R. K. Bequette for wheat flour samples to test the applicability of the method.

List of References

(1) Pamela M. Bell and D. H. Simmonds, Cereal Chem. *40*, 121-8 (1963).

(2) G. A. H. Elton and J. A. D. Ewart, J. Sci. Food Agr. *13*, 62-72 (1962).

(3) Janet S. D. Graham, Austral. J. Biol. Sci. *16*, 343-9 (1963).

(4) J. W. Lee, Biochem. Biophys. Acta *69*, 159-60 (1963).

(5) C. C. Nimmo, Mary T. O'Sullivan, A. Mohammad, and J. W. Pence, Cereal Chem. *40*, 390-8 (1963).

(6) C. W. Wrigley, J. Sci. Food Agr. *14*, 120-4 (1963).

Report of Committee on Maintainance of Genetic Stocks in Wheat

A resolution at the First International Wheat Genetic Symposium established a committee to organize and co-ordinate a system for maintaining, on a voluntary basis, wheat stocks of known genetic constitution and arrange for a suitable means of recording and disseminating the information.

Many of the wheat workers throughout the world interested in genetic stocks are breeders and their primary interest is in varietal phenotypes and their preservation. Genetic studies often are by-products of their breeding programs. Only a few workers devote their entire time to wheat genetic and cytogenetic problems. This makes it important that some method of preservation of genetic stocks be organized so that factors already reported upon are available for study by people working on the same characters.

The committee recommended at the Second International Wheat Genetic Symposium that:

1) Wheat workers voluntarily agree to maintain viable seed of genetic factors reported upon and cytogenetic stocks available and that the list of these genetic stocks be currently published in the Wheat Information Service. This information will also be published in the Wheat Newsletter and distributed by FAO.

2) Stock lists of species and genera of *Triticum* and *Aegilops* (and other related genera) be published. WIS has already done this and will continue to do so.

3) Only 10-15 seeds be supplied to other research worker of each stock. Discussion concerning the time and expense involved in maintaining such stocks suggested some charge be made for each stock as is done with the American Type Cultures. However, because of the probable small charge and number of countries involved this item could not be resolved. Those requesting seed stocks should be conservative in their requests.

4) The commitee should locate some adequate storage facilities in which to keep these genetic stocks. This would assure (in most cases) that the stocks were stored in duplicate. The stocks placed in such storage would not be used for general distribution.

5) Symbols assigned to characters should closely follow the reports of the International Committee on Genetic Symbols and Nomenclature of the Permanent International Committee for Genetics Congresses.

In order to avoid assigning the same symbol to different characters, or the same subscript number, some consideration should be made in the future toward some standard procedure of assigning symbols in wheat.

Those who will maintain genetic stocks, should list their materials along with the published references and send the informations to E. G. HEYNE, Waters Hall, Kansas State University, Manhattan, Kansas, U. S. A.

The committee members:

E. G. HEYNE, Chairman
K. YAMASHITA
R. G. ANDERSON
R. RILEY
B. C. JENKINS

A Documintary of the Botanical Expedition to the Heart of the *Aegilops* Distribution

SCENARIO

by

K. YAMASHITA

Biological Laboratory, Yoshida College, Kyoto University, Kyoto, Japan

Introduction

A graciously extended grant by the Rockefeller Foundation enabled the Kyoto University, Kyoto, Japan, to carry out the long planned expedition, recorded under the titel: Botanical Mission of the Kyoto University (BMUK), Kyoto, Japan; Dr. Masatake TANAKA, Assistant Professor, Dr. Osamu SUZUKA, Lecturer, and Mr. Seiji NAKAMURA, Cameraman of the Nichiei Co., Tokyo, Japan. The editing and printing costs of the film have been partly defrayed by a Grant in Aid from the Ministry of Education, Government of Japan. The presented film was completed in March, 1963 by the Nichiei Co., Tokyo, Japan.

We have Einkorn wheat, Emmer wheat and Dinkel wheat. Dinkel, our bread wheat, is known to have developed from the hybrid of Emmer and ***Aegilops squarrosa***. Similarly, our Emmer wheat would have its origin in a cross of Einkorn with an unknown plant. What was the B-genome donor to wheat?

The regions from Egypt, Lebanon and Jordan, through Syria and Turkey, to Greece were covered by the expedition.

The following table shows a list of the collections.

Aegilops mutica and the species of the ***Sitopsis*** section will be most useful for our further studies in relation to the origin of wheat.

Now, Ladies and Gentelmen: we are very pleased to present an aerial view of the Nile, the artery of life in Egypt. Its water nourishes the Delta, which HERODOTUS described as " ***doron tou potamou*** ".

The CHEOPS Pyramid in Gizah. The elevation angle of the edge we climed with efforts is approximately 42 degrees. We were rewarded by a grand view of the Desert and the Oasis commanded, from the top of the height of 147 meters.

The History of the Earth
is written in its Layers;
The History of living Organisms
is inscribed in the Chromosomes.

H. Kihara 1947

Number of strains of collected *Triticum* and *Aegilops*

1. *Triticum*

Material	Region	Egypt	Jordan	Lebanon	Syria	Turkey	Greece	Italy
Einkorn:	Wild type				1	47	7	
	Cultivated type						9	
Emmer:	Wild type		1			2		
	Cultivated type	8	15	4	12	54	3	6
Dinkel:	Cultivated type	30		1	14	91	9	3

II. *Aegilops*

Species	Region	Egypt	Jordan	Lebanon	Syria	Turkey	Greece	Italy
Polyeides:	*umbellulata*		1		2	72		
	ovata		9	7	19	51	8	22
	triaristata (4x, 6x)					69	52	6
	biuncialis			6	7	97	1	
	columnaris					6		
	variabilis (incl. *Kotschyi*)	28	119	7	12	8	41	1
	triuncialis			9	10	166	54	
Cylindropyrum:	*caudata*				3	30	39	
	cylindrica				1	28		
Comopyrum:	*Heldreichii*					6	20	
	uniaristata						1	
Vertebrata:	*crassa*		2	1	1			
	ventricosa	1						
Amblyopyrum:	*mutica*					65		
Sitopsis:	*speltoides*				13	7		
	Aucheri				15	12		
	longissima		9	2	7			
	bicornis	27						

The AUZONIA, an Italian Ship from Alexandria. The members aboard.

Beirut - the Mediterranean front. "A Phoenician style bread this is!". "How about carrying one on your arm for lunch, Sir? Good idea!".

An ancient difficult pass at **nahar el kalb** in the north of the city. The epigraphs on a cliff tell the stories of the Assyrian, Egyptian and many other great conquerors in the history, who passed here. The road leads through the olive plantations south to Sidon, a Phoenician port, known for a crusade castle on the sea.

The samples of ***Aegilops*** from Lebanon. From the left they are: ***longissima, crassa, umbellulata, ovata, biuncialis*** and 3 forms of ***variabilis***.

Happy to introduce ourselves: YAMASHITA, SUZUKA on side seat, and TANAKA on back seat.

There lies the range of Mt. Hermon. In 1906, AHRONSOHN found ***T. dicoccoides,*** a wild Emmer, from its skirting area. A habitat in Soueida, Southern Syria, was adorned with ***Cousinia*** and ***Adonis***. We hunted for ***T. dicoccoides,*** and finally we found the species there, between lime stones.

To Northern Syria. Villagers were just busy in harvesting wheat. The farm houses have cone formed roofs. They explained a hole on the roof top is good for ventilation.

Leaving the village, near Aleppo, we advanced toward the Turkish border. Our trouble was to go through the necessary procedures to clear the custom. But we had to, because **plant species grow without recognizing political boundaries.**

Everything was okayed, and we entered Turkey, accompanying a Syrian fly on the wind shield of our jeep. Boys came to our jeep to sell wheat decorations they had made. Poor botanists, though, we were merely interested in the species used - - - ***T. durum.***

People were curious to observe strange visitors on a Japanese jeep. A cap became a symbol of Turks, since KEMAL PASHA abolished the traditional fez worn for centuries.

Ankara, the capital of Turkey. The ATATURK Boulvard with its modern atmosphere.

We visited the Department of Agronomy, of the Ankara University. Dr.

TOSUN showed us his fields. He told us that ***Triticum monococcum,*** a diploid species, is widely cultivated in Turkey.

A wheat field near Ankara of ***Triticum durum.***

Along the highway, a wild Einkorn, ***Triticum aegilopoides,*** formed a large population. The population was found to involve variations in color, awning and other characteristics. We took very valuable data from this habitat.

Aegilops mutica. The two on the right are the compact heads, probably new to science, and they seem to be most important. The two on the left are the normals.

The Bosporas strait. A view of Istanbul with a mixture of old and new.

Over the Aegean Sea, we flew down to Greece. A birdeye view of the city of Athens. We visited Elevsis, an old historical town in the north of Athens. Among the mysterious characters exhibited, TRIPTOLYMOS receives the legendary ears of wheat from DEMETER for all mankind. ***Aegilops*** abounded in the mythological temple ground: for instance, ***Aegilops biuncialis.***

With the mythological thoughts of the origin of wheat in our mind, we turned back to the highland above the fertile crescent in Asia Minor where possibly our Emmer wheat originated.

Mt. Ararat, 5200 meters high, known for the legend of the NOAH's Ark about 6 to 7 thousand years ago as described in the Genesis of the Bible.

We returned to Egypt. Here are presented a few sections of the mural paintings of wheat culture of MENES in Thebes. Look at the pose and the tool. In reality, they still exist, and are in use in Northern Syria.

The Agricultural Museum in Cairo. Dr. TÄCKHOLM, received us very warmly, and assisted us kindly to examine the excavated wheat grains found in the pyramids. The oldest samples are 7000 years old and were identified as ***Triticum dicoccum.*** She said that the age of the carbonated grains was also ascertained by the C^{14} method to be about 6500 years, which conforms well with the archaeological estimation.

However, this species is not grown there today. The majority of the present wheat belongs to ***Triticum aestivum,*** called "hindi" in Arabic.

According to FIKRY this is a recent introduction and has threshable ears. Were the grains preserved in the Pyramids produced there, or were they brought in from the neighbouring regions?

The history of wheat is the history of culture; The pyramids their vigil keep.

END

Crop Terminology

The 1963 CSSA Committee on Crop Terminology reports on (a) terminology for cytoplasmic male-sterility in field crops, and (b) other crop terminology.

Cytoplasmic Male-Sterility

Terminology involved in cytoplasmic male-sterility in various field crops is being emphasized in the current report of the CSSA Committee on Crop Terminology. Emphasis is placed on the terms used in corn, sorghums, and sugar beets in an attempt to standardize designations for different field crops, so far as possible.

Indian Corn or Maize (*Zea mays L.*)

Cytoplasmically induced male-sterility in corn, commonly termed "cytoplasmic male sterility" or "cyto-sterility", is caused by an interaction between cytoplasm and nuclear genes. Two types of male-sterility-inducing cytoplasm are known: The Texas or "T" type, and the USDA or "S" type. All other discoveries of male-sterile cytoplasm to date appear to be indistinguishable from either "T" or "S".

The genetic symbols in common use are as follows:

cms: A cytoplasm that induces male sterility. This symbol may carry subscripts 1 to n, to denote specific cytoplasms.

Rf, *rf*: Genes that affect pollen fertility restoration. These are given subscripts to denote different loci. Occasionally, they have also been given superscripts to designate the appropriate cytoplasm, but this practice is not general.

Rf_1 is the most important locus, for commercial use. In the presence of Texas cytoplasm (cms_1) Rf_1 Rf_1 and Rf_1 rf_1 are pollen fertile, while rf_1 rf_1

is pollen sterile. Modifiers of unknown number and location affect the expression of Rf_1.

Corn breeders use a slightly different practical system of terminology, based primarily on the phenotype, to label inbreds used to produce hybrids. The *cms* term is replaced by a T or S to indicate the Texas or USDA source of cytoplasm. Thus, when the subscript is used for the Texas source, the two usages for WF_9 inbred would be as follows: *cms* WF_9 and WF_9 (T). Rather general use is made of *Rf* and *rf* (Usually refers to Rf_1 and its effect in cms_1).

It would seem to be simpler (for routine commercial use) to use a single letter to designate the four possible homozygous states of an inbred with regard to a single cytoplasm as follows:

Genetic Symbols		Practical Symbols	Description
cms_1	$rf_1\ rf_1$	WF9 - T (or A in sorghums)	Pollen sterile, Texas cytoplasm
------	$rf_1\ rf_1$	WF9 - N (or B in sorghums)	Pollen fertile maintainer, normal cytoplasm.
cms_1	$Rf_1\ Rf_1$	WF9 - R	Pollen fertile restorer, Texas cytoplasm
------	$Rf_1\ Rf_1$	WF9 - F	Pollen fertile restorer, normal cytoplasm.

The Terminology Committee recommends the above symbols for cytoplasmic male-sterility in corn, but also that a different set of symbols be used to designate a different cytoplasm.

In the preparation of the statement on cytoplasmic male-sterile terminology in corn, the Committee wishes to acknowledge the assistance of:

(a) Donald N. Duvick, Pionier Hi-Bred Corn Company, Johnston, Iowa.

(b) G. F. Sprague, Leader, Corn and Sorghum Investigations, Crops Research Division, Agricultural Research Service, U. S. Department of Agriculture, Beltsville, Maryland.

Sorghums (*Sorghum vulgare* Pers.)

At the present time, only one cytoplasmic male-sterility system is used in the commercial production of hybrid sorghum seed. It was discovered through the introduction of kafir chromosomes into milo cytoplasm. The male sterility is caused by an interaction between male - sterility - inducing cytoplasm and specific nuclear genes. Male fertility as well as male sterility in the sterility-inducing cytoplasm are controlled by a single factor pair designated $Ms_c ms_c$. The homozygous ($Ms_c Ms_c$) or heterozygous ($Ms_c ms_c$) dominants produce pollen fertility, whereas the homozygous recessives ($ms_c ms_c$) produce male sterility. The F_2 generation segregates 3 fertile to 1 male - sterile.

A wide range of partial fertility occurs in the pollen - fertile (Ms_c) class as a result of inter - allelic and intra - allelic interactions of two factor pairs designated $Pf_1 pf_1$ $Pf_2 pf_2$. The lowest pollen fertility (5 - 10 %), as determined by percentage of stained pollen, is found in the double - recessive genotype, $pf_1 pf_1 pf_2 pf_2$. The homozygous dominants, $Pf_1 Pf_1 Pf_2 Pf_2$, have approximately 90 % of stained pollen.

Sorghum breeders use the practical terms A, B, and R for pertinent lines used in the production of sorghum hybrids. The A line designates the cytoplasmic male - sterile line, produced by crosses of a given line into male - sterility - inducing cytoplasm followed by successive backcrosses to the given line. Genetically, it is $ms_c ms_c$ in male - sterility - inducing cytoplasm. In seed - production fields, it is generally called the seed parent. The sterility - maintainer is called the B line. It is a pollen - fertile line that has been used to produce a cytoplasmic male - sterile (A line) counterpart by recurrent backcrosses. Genetically, the B line $ms_c ms_c$ in normal or fertility - inducing cytoplasm. The fertility - restorer line is the R line that is fertile in sterility - inducing cytoplasm, or that produces normal pollen fertility in the F_1 of a cross with a cytoplasmic male - sterile line. Genetically, the R - restorer line is $Ms_c Ms_c$. In seed - production fields, it is generally called the pollen parent.

Some breeders, but particularly hybrid seed producers, use the letter designations with variety names, e.g., A - Martin and B - Martin. More frequently they are used with serial numbers, as A - 398 and B - 398 for male - sterile and male - fertile Martin, respectively. The R designation is generally used with a serial number, as R - 7005 for the fertility - restorer variety Plainsman.

The CSSA Crop Terminology Committee recommends that the above symbols for cytoplasmic male - sterility in sorghums be accepted.

The Committee wishes to express its gratitude to J. C. Stephans, Agronomist, Cereal Crops Branch, Crops Research Division, Agricultural Research Service, U. S. Department of Agriculture, Chillicothe, Texas, for his assistance in the statement of terminology involved in sorghum hybrids.

Sugar Beets (*Beta vulgaris* L.)

Cytoplasmic male-sterility (*cms*), known in sugar beets for a number of years, is now used in the production of hybrids. Cytoplasm which can induce male-sterility occurs in many commercial open-pollinated varieties, as well as in many wild races of *Beta vulgaris*. Male-sterility results from the interaction of certain nuclear genes with a male-sterility inducing cytoplasm. The mode of genetic inheritance has not been fully resolved, nor have the various sources of cytoplasm been studied sufficiently to ascertain whether differences exist between them.

Sugar beet breeders use male-sterile terms in ways as follows:

(a) A cytoplasmic male-sterile line is comprised only of male-sterile individuals, being produced by backcrosses to an O-type line.

(b) O-type sugar beets are those with a genotype such that, when the beet is crossed with a male-sterile (*cms*) beet, the progeny are all male-sterile (*cms*). O-type sugar beet lines are used as (1) maintainers of male-sterile lines, and (2) as pollen parents of male-sterile F_1 hybrids which are used as seed parents of commercial hybrids. The O-type line is understood to have normal cytoplasm. Dr. F. V. OWEN, the originator of the term, meant O (zero)-type. Since the death of Dr. Owen, sugar beet breeders have used the term, O-type, as a tribute to him, i.e., O(wen) type.

(c) Sugar beet breeders usually are not concerned with restorer types because the end product is roots rather than seed. Furthermore, no sugar beet breeders or geneticists have reported the existence of any beet with a genotype that will cause complete restoration of viable pollen production in the progeny of a cross with a cytoplasmic male-sterile sugar beet.

The Terminology Committee recommends that the above symbols for cytoplasmic male-sterility in sugar beets be accepted.

The committee is grateful to Robert K. OLDEMEYER, Director, Seed Development, Agriculture Experiment Station, Great Western Sugar Company, Longmont, Colorado, for his being liaison between the Sugar Beet Breeders Forum and the Terminology Committee as regards the accepted usage of terms for sugar beets.

Other Field Crops

Cytoplasmic male-sterility has also been established in pearl millet (*Pennisetum glaucum* L.) R. Br.. Fertility restorers appear to be unnecessary in countries like the United States where pearl millet is used only as a forage plant. Sterility in the commercial hybrid would prevent the farmer from saving seed from the F_1. This would save him the yield losses that result when F_2 generations are grown. Sterility would also help to maintain the hybrid in a vegetative condition. [1/] More work needs to be done before commercial hybrids will be available.

Cytoplasmic male - sterility has also been reported in common wheat (*Triticum vulgare* L.) as well as in sunflowers (*Helianthus annus*).

General Recommendation

The CSSA Committee on Crop Terminology recommends that investigators who discover cytoplasmic male - sterility in other field crops be guided by the possible use of the established terminology in corn or sorghums or sugar beets, in order to achieve uniformity of terminology so far as possible.

Other Crop Terminology

It is recommended by the Committee that CASTORBEAN be spelled as one word. This is consistent with the general policy of the Crop Terminology Committee in the past.

Respectfully submitted,

R. MERTON LOVE
M. E. HEATH
WARREN H. LEONARD
Colorado State University Fort Collins, Colorado, U.S.A.

---

*1/ Burton, G.W. Cytoplasmic male - sterility in pearl millet (*Pennistum glaucum* L.) R. Br., Agronomy Journal 50 : 230 - 231, 1958.

The identification of physiologic races of *puccinia graminis* var. *tritici* by wheat isogenic or substitution lines, carrying genes for resistance

A. R. da Silva e E. T. Coelho
Escola Agronomia Eliseu Maciel, Pelotas, Rio Grande do Sul, Brasil

Using the isogenec lines obtained by Dr. D. R. Knott from Canada through backcrossing to Marquis, resistant varieties, with the genes *Sr* 6, *Sr* 7, *Sr* 8, *Sr* 9 and *Sr* 10; and the lines of the variety Chinese with the following chomosome substituted: Thatcher XIX (carries the gene *Sr* 5), Red Egyptian (carries the gene *Sr* 6), Red Egyptian VI (carries the gene *Sr* 8), Red Egyptian XIII (carries the gene *Sr* 9), Timstein X (carries the gene *Sr* 11), Hope III,VIII,XVII and Thatcher III and XIII obtained by Dr. E. R. Sears from United states, it was possible to recognize physiologic races of stem rust with information more usefull for breeding for resistance than by the use of the international set.

Table 1. The reaction of physiologic races of *Puccinia graminis* var. *tritici* to genes for rust resistance

Genes Races	*Sr* 5	*Sr* 6	*Sr* 7	*Sr* 8	*Sr* 9	*Sr* 10	*Sr* 11
11	S	R	R	S	R	S	R
11 T×	S	R	R	S	R - S	S	S
15	S	R	R	R	S	S	S
17	R	R	R	S	S	S	R
17 - 61×	R	S	S	S	R	S	R
17 - 63×	R	S	R	S	S	S	R
17 - T	R	R	R	S	S	S	S

R = resistant; S = susceptible; R-S resistant to gene *Sr* 9 from Kenya 117a but susceptible to gene *Sr* 9 from Red Egyptian; × new race

There is published the pedigree of a large number of wheat varieties descendent from Kenya varieties and from Reliance, Thatcher, Newthatch, Frontana and others and Dr. Knott has identified the genes that condition resistance to stem rust races 15 B and 56 in these varieties.

With such information available, the race identification through the use of genes, provides very usefull information to breeding for rust resistance because the breeder will know the possible sources of resistance and can choose the one which is more similar to its own material well adapted to its local conditions, can organize the crosses to have the more wide basis of resistance and is able, by the inoculation of races, to know which lines after a cross have different genes for resistance.

Transmission of monosomes and trisomes in an Emmer wheat, *T. dicoccum* var. Khapli

K. TSUNEWAKI
National Institute of Genetics, Misima, Japan

As reported earlier (KIHARA and TSUNEWAKI 1960, 1962; TSUNEWAKI 1962), several aneuploids of an Emmer wheat, *T. dicoccum* var. Khapli were produced among polyploids by N_2O-treatment of artificially pollinated spikes. Three monosomics and 6 trisomics were obtained so far. Transmission of the monosomes and trisomes to their offspring has been studied. The result is summarized in Table 1.

No monosomics were recovered in the offspring of all 3 monosomics, although 2 trisomics were found. No transmission or a very low one of monosomes seems to be due to the low fertility of chromosome-deficient female gametes, becaus seed fertility of the monosomics was very low (about 30%) even at artificial pollination with pollen grains from disomic Khapli. This fact indicates that monosomics of, at least, this Emmer wheat are not suitable for genetic investigation, except that they might serve as a source of trisomics.

On the other hand, many trisomics (24% on the average) were obtained in the offspring of trisomics. A single tetrasomic was also found. Transmission rates of the trisome through female and male gametes were estimated to be 23% and 2%, respectively. Transmission rate of the trisome in this Emmer wheat is much lower than that reported for common wheat but is almost the same as in barley. Trisomics of the employed Emmer wheat, therefore, may be convenient for genetic study.

Table 1. Fertilities of mono- and trisomics of *T. dicoccum* var. Khapli and the frequency of aneuploids in their offspring

Plant	% Seed set (selfed)	No. of offspring				
		Total examined	Monosomics	Trisomics	Tetrasomics	Haploids
Monosomics						
K-mono-1	20.0	8	0	1	-	-
,, -2	35.0	5	0	-	-	-
,, -3	39.3*	11	0	1	-	-
Total	33.1	24	0	2	-	-
Trisomics						
K-tri-1a	100.0	36	-	9	0	-
,, -1b	92.5	38	-	6	1	-
,, -1c	83.3	35	-	9	0	1
,, -2	82.5	35	-	10	0	-
,, -3	62.5	24	-	6	0	-
,, -4	73.3	37	-	9	0	-
Total	82.3	205	-	49	1	1

*Seed fertility by artificial pollination with normal pollen

Relation of radiation effects to dose rates of gamma-rays in diploid wheat

S. Matsumura and T. Mabuchi
National Institute of Genetics, Misima, Japan

In order to investigate the relation of radiation effects to dose rates, dry seeds of *Triticum monococcum flavescens* were irradiated by gamma-rays at 4~15 kr. For acute and chronic irradiation the dose rates, 10,000 r/hr with ^{137}Cs and 35.6 r/hr with ^{60}Co, were used, respectively. Chronic irradiation was slightly more effective in inhibiting seedling growth than the acute treatment applied at the beginning of the chronic, and was clearly less effective than that applied at the end of the latter. Also, acute irradiation showed clearly a higher chlorophyll mutation rate than the chronic did, which were terminated just before sowing. The later was the irradiation at the same dose, the more pronounced was the inhibition of seedling growth and the increase in chlorophyll mutations, especially at acute irradiation. Thus, almost no intensification of radiation damage due to storage effects was found, as already reported in Annual Report of National Institute of Genetics, No. 13: 97-99.

A series of similar experiments with the same material was initiated to verify the earlier studies. Dry seeds were exposed to gamma-rays at the dose rates, 10,000 r/hr with ^{137}Cs and 26 r/hr with ^{60}Co, respectively. In general chronic irradiation was more effective in inhibiting seedling growth and increasing chlorophyll mutations than the acute treatment, applied at the end of the chronic, especially at high dose (15 kr). It is supposed, against the earlier studies, that a slight intensification of radiation damage due to storage effects was involved.

Relation between polyploidy and effects of gamma- and neutron-radiation on wheat

S. Matsumura
National Institute of Genetics, Misima, Japan

Exposure to 14 MeV neutrons obtained from (D, T) reaction was carried out in the Biology Division of Oak Ridge National Laboratory. For the calculation of given doses, based on Randolph's method, the analysed elemental compositions and the measured fast-neutron fluxes were used. The dose, applied to dormant seeds, ranged from 0.48 to 1.80 krad for *Triticum monococcum* and from 0.95 to 2.24 krad for *T. durum* and *T. vulgare*. At the same time gamma-radiations were used for comparison at 4.3~17.2 krad ORNL.

After exposure to 1.80 krad of fast neutrons, the seeds of *T. monococcum* germinated but most of the seedlings died in an early stage, while in *T. durum* and *T. vulgare* slow growth of the seedlings continued even at 2.24 krad of fast neutrons. The higher was the dose of fast neutrons and gamma rays, the more delayed were germination and growth of seedlings, the more reduced were survival rate and seed fertility, and the more increased were chlorophyll mutations, with the exceptions of mutations in *T. vulgare* (Table 1). In general, *T. monococcum* is the most sensitive to fast neutrons and gamma-rays. There is no significant difference between *T. durum* and *T. vulgare*. Also the relative biological effectiveness (RBE) of fast neutrons to gamma-rays was found to be 10~15 for those properties in *T. monococcum*. The RBE values for these characters in polyploids were higher than in *T. monococcum*, respectively.

Table 1. Effects of γ-rays and fast neutrons (14 MeV)

Dose	Germination (%)	Length of seedlings (cm)	Survival (%)	Fertility in X_1 (%)	Chlorophyll mutation rate in X_2 (%)
T. monococcum flavescens (2n=14)					
Control	70	11.07	75.71	55.00	0.00
krad γ- 4.3	75	10.03	56.00	41.57	4.47
γ- 8.6	68	8.09	58.82	24.96	5.93
γ-12.9	57	5.95	54.39	24.24	4.59
N-0.48	72	9.45	52.11	38.34	1.85
N-0.95	61	5.96	50.82	25.53	16.16
N-1.43	50	3.85	32.00	10.45	6.06
N-1.80	38	2.04	0.00	-	-

continued

T. durum Reichenbachii (2n=28)

Control	72	10.21	72.22	38.37	0.00
krad γ- 3.6	86	11.00	83.72	44.07	0.00
γ-12.9	84	10.16	64.29	43.16	0.00
γ-17.2	76	9.92	81.58	44.64	4.10
N-0.95	74	9.37	54.05	32.62	8.16
N-1.43	84	8.58	40.47	14.62	4.76
N-1.80	74	8.01	29.73	24.45	10.00
N-2.24	72	5.41	8.33	14.03	0.00

T. vulgare erythrospermum (2n=42)

Control	66	15.90	93.94	22.36	0,00
krad γ- 8.6	58	14.82	89.66	13.11	0.00
γ-12.9	68	14.36	89.66	7.92	0.00
γ-17.2	68	12.31	70.59	5.62	0.00
N-0.95	70	14.10	71.43	9.22	0.00
N-1.43	32	13.15	53.66	9.25	0.00
N-2.24	71	9.05	19.35	4.18	0.00

RBE value 14 MeV fast neutrons to ^{60}Co gamma-rays in *T. monococcum*

T. Fujii

National Institute of Genetics, Misima, Japan

RBE value of 14 MeV neutrons to gamma-rays in einkorn wheat was studied by using the specific loci method. Dry dormant normal seeds and F_1 seeds from the cross between normal-5001 and *chlorina*-5040 were subjected to 4.3~12.9 krad of gamma-rays and 0.48∼1.43 krad of neutrons. Mutations from dominant normal green to *chlorina* occurred by both irradiations and appeared in the leaves and stems of the heterozygotic X_1 plants as longitudinal stripes.

Around 80 per cent of seeds germinated in the control lot and in the lowest dosage lots from both neutron and gamma-ray irradiation, and germination percentages were gradually decreasing with increasing dosage of both kinds of radiation. Moreover, a similar tendency was observed in early stages as to seedling growth which was gradually inhibited with increasing dosage. According to these results, neutron irradiation was about 13 times as effective as that of gamma-rays. Survival rate in the non-irradiated control was about 90 per cent and about 50-80 per cent of germinated seedlings survived in 0.45 and 0.95 krad lots from neutron irradiation from all lots irradiated by gamma-rays. On the other hand, only about 4 per cent of germinated seedling survived in the highest neutron lot.

No mutation was observed in the control lot, and the number of plants which contained striped tillers increased with increasing dosage of both kinds of radiation as shown in Table 1. The rates for striping were calculated per spike and 0.19, 0.35 and 0.48 × 10^{-6} per krad were obtained from 4.3, 8.6 and 12.9 krad gamma-ray irradiation, respectively. 0.95 and 7.12 × 10^{-6} per krad were obtained from 0.48 and 0.95 krad neutron irradiation. 1.43 krad neutron irradiation is too high for einkorn wheat. From the results, RBE value of 14 MeV fast neutrons to ^{60}Co gamma-rays was about 13.

Table 1. Frequency of somatic mutations

Strain	Treatment (krad)	No. of individuals[1]	No. of spikes		Chlorina stripes	
			Total	Average per plant	No. of plants	No. of spikes (%)
Normal	Control	104 (80.0)	4115	39.6		
	Neutron-0.48	110 (76.4)	3877	35.2	1	1(0.026)
	〃 -0.95	83 (63.4)	2470	29.8	1	2(0.081)
	〃 -1.43	6 (4.6)	124	20.7		

- continued -

F_1	Control	256 (87.7)	10167	39.7		
	Neutron-0.48	474 (72.3)	16411	34.6	50	76(0.463)
	„ -0.95	322 (50.8)	9461	29.4	31	64(0.676)
	„ -1.43	23 (3.7)	430	18.7	4	11(2.558)
	γ-ray - 4.3	582 (86.2)	21316	36.6	6	17(0.080)
	„ - 8.6	474 (74.5)	17734	37.4	29	53(0.299)
	„ -12.9	348 (60.1)	11421	32.8	31	71(0.621)

1) No. in brackets shows the survival rate of germinated seedlings.

Frequencies of Ne_1 and Ne_2 genes in Emmer and common wheats

K. TSUNEWAKI and K. NISHIKAWA
National Institute of Genetics, Misima, Japan

Three complementary genes, Ne_1, Ne_2 and Ne_3, cause in combination a progressive necrosis in common wheat. Ne_1 gene is located in B, Ne_2 in A and Ne_3 in D genome. Among them, Ne_1 and Ne_2 were extensively investigated by CALDWEL and COMPTON (1943), HEYNE, WIEBE and PAINTER (1943) HERMSEN (1957, '59, '62, '63,), SCHMALZ (1959) TSUNEWAKI (1960) and TSUNEWAKI and KIHARA (1962). The number of examined varieties amounts to 520. For 4 of them, a contradictory result was reported by different authors. Those two genes are also found in Emmer wheat and their distribution among 41 varieties was investigated by TSUNEWAKI and KIHARA (1962) and NISHIKAWA (1962a, b). Excluding the contradictory cases, frequencies of 4 possible genotypes in two groups of wheat are summarized in Table 1. From these results, frequencies of individual alleles were calculated and are listed in the same table.

In Emmer wheat, frequencies of 4 genotypes are in good agreement with those expected from random assortment between two pairs of alleles. Concerning each allelic pair, the dominant allele predominates in the Ne_1 series, while the recessive is prevalent in the Ne_2. In common wheat, frequencies of 4 genotypes deviate from those expected from random assortment. Frequencies of $Ne_1Ne_1ne_2ne_2$ and $ne_1ne_1Ne_2Ne_2$ are much higher than the expected ones from randomness. In this group of wheat, the recessive allele is predominating in the Ne_1 allelic pair, while the frequencies of the 2 alleles of the other pair were not markedly different from each other.

Those results clearly indicate that: (1) two genotypes, $Ne_1Ne_1ne_2ne_2$ and $ne_1ne_1Ne_2Ne_2$, are preferentially selected in common wheat against the two others, and (2) a shift in the gene frequencies must have occurred at the hexaploid level in favor to Ne_2 and especially ne_1.

Table 1. Frequencies of 4 genotypes and alleles for necrosis in Emmer and common wheats

	Emmer wheat		Common wheat	
	Actual	Expected*	Actual	Expected*
Freq. of each genotype (No. of varieties)				
$Ne_1Ne_1Ne_2Ne_2$	6	4.53	1	35.38
$Ne_1Ne_1ne_2ne_2$	25	22.47	87	52.85
$ne_1ne_1Ne_2Ne_2$	0	1.46	206	171.53
$ne_1ne_1ne_2ne_2$	10	8.54	222	256.23
Total	41	41.00	516	515.99
Freq. of each allele (Relative freq.)				
Ne_1	0.756		0.171	
ne_1	0.244		0.829	
Ne_2	0.146		0.401	
ne_2	0.854		0.599	

* Expected from random assortment between two pairs of alleles.

Editorial Remarks

Explanation of the Figure on the cover

Protein patterns obtained by electrophoresis of aluminium lactate buffer extracts of wheat flours in polyacrylamide gels. Top to botton: a blended composite medium - protein bread - type flour; Lakota *durum* wheat; Atlas 66 soft red winter wheat; Bankuti 1205 hard red winter wheat; Bankuti 1201; and Stewart *durum* wheat.

(John M. Lawrence and D. R. Grant, s. page 20)

Announcement for further issues

WIS Nos. 19 and 20 will be published during the fiscal year from April 1964 to March 1965. Manuscripts for those issues are accepted any time, and they will go to press in sequence as soon as they cover the planned pages of each number. WIS is open to all contributions regarding methods, materials and stocks, ideas and research results related to genetics and cytology of *Triticum, Aegilops, Agropyon, Secale* and *Haynaldia.*

The manuscripts should not exceed 3 printed pages. List of stocks is exempted from this page limit. No illustrations are accepted for this publication.

Communication regarding editorial matters should be addressed to:

Dr. Kosuke Yamashita
Wheat Information Service
Biological Laboratory,
Yoshida College, Kyoto University, Kyoto, Japan

Coordinating Committee

Editorial Board

Acknowledgement

The cost of the present publication has been defrayed partly by the Grant in Aid for publishing Research Results from the Ministry of Education, Government of Japan, and partly by contributions from the Flour Millers Association, Tokyo, Japan. We wish to express our sincere thanks to those organizations. We should also like to express our sincere gratitude for favorable comments regarding WIS Nos. 1 - 16, and the valuable contributions for the present numbers. Increased support for further issues would be appreciated.

The Managing Editor

Printed by:
DOILAB SHOKAI
34, HIGASHI 1-CHOME, SHIGINO, JOTO-KU,
OSAKA