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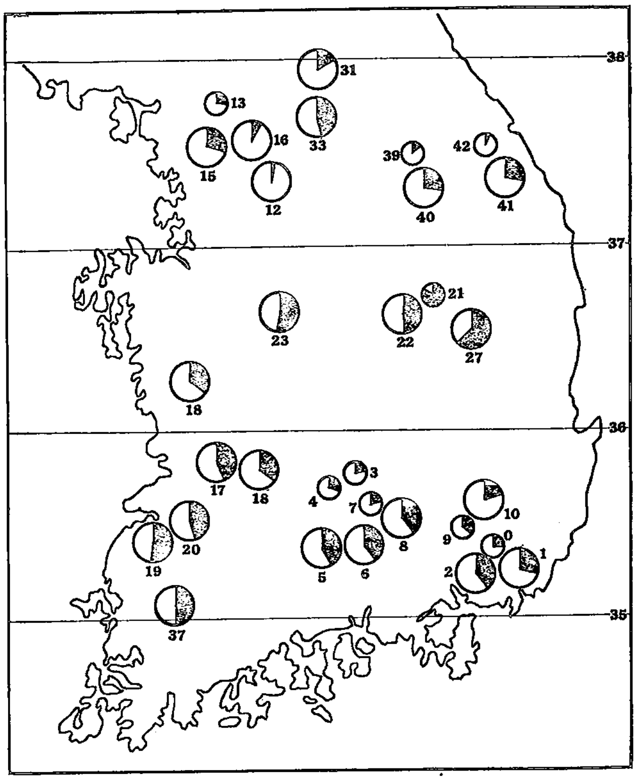

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I. RESEARCH NOTES

The mechanism regulating pairing in *Triticum timopheevi* [1]

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UPADHYA and SWAMINATHAN (Indian Jour. Genet. & Pl. Breed., 1965) studied the mechanism regulating pairing in *T. zhukovskyi*, a natural autoallohexaploid which arose presumably from the cross *T. timopheevi* × *T. monococcum*. In a comparative study of meiosis in the 41- and 42-chromosome hybrids between Chinese Spring Mono-5B and *T. zhukovskyi*, they found that the number of chromosomes entering into associations increased when 5B of Chinese Spring was absent. Thus, they concluded that a gene system similar to that found in chromosome 5B of *T. aestivum* var. *vulgare* might not be present in *T. zhukovskyi*, and, therefore, also not in *T. timopheevi*.

In the course of my work, 41- and 42-chromosome hybrids were obtained from the cross of Chinese Spring Mono-5B with the amphidiploid *T. timopheevi—Ae. squarrosa*. The 42-chromosome hybrid showed slightly more chromosomal pairing at metaphase I (see table). This is actually what is expected in disomic conditions as compared to monsomic. These mean pairing values indicate that *T. timopheevi* chromosome which corresponds to 5B of Chinese compensates completely for the nullisomci condition of Chinese 5B. It appears, therefore, that *T. timopheevi* contains a gene system on this chromosome identical with that found in chromosome 5B of *T. aestivum*.

1) This work was supported by a grant from the National Science Foundation to Dr E. R. SEARS.

The mean chromosomal pairing in 41- and 42-chromosome hybrids of the cross *T. aestivum* var. Chinese Spring Mono-5B × *T. timopheevi* – *Ae. squarrosa* amphidiploid

	5B of Chinese*	Cells observed	Univalents	Bivalents			Multivalents		Xmata
				Rod	Ring	Total	III	IV	
42 – chromosome hybrid	+	50	8.92±0.34	5.48	9.50	14.98±0.22	0.88±0.09	0.12±0.03	27.20±0.30
41 – chromosome hybrid	–	50	10.50±0.36	4.76	9.28	14.04±0.22	0.70±0.09	0.08±0.03	27.28±0.36

* + : present, – : absent

Differences in effects of γ-rays and fast neutrons on wheat

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1. γ-rays and fast neutrons from Po-Be source on einkorn wheat

Fast neutrons were obtained from a Po-Be source. The nuclear reaction is ${}^{9}_{4}Be$ (α, n) ${}^{12}_{6}C$, and ${}^{210}_{84}$ Po, whose half life is 138 days, is used as a α-emitter. The resultant neutrons are emitted as discrete spectrum with the maximum energy of 11 MeV and a mean energy of approximately 7.2 MeV. Dry seeds were attached to the surface of a stainless steel cylinder of 10 cm diameter, which contained the Po-Be neutron source (^{210}Po 10 c) in the center.

The irradiation dose, preliminarily applied to einkorn wheat seeds, ranged from 24 to 125 rad for 3 ~ 15 days. At the same time γ-radiations with ^{137}Cs 6,000 c were used for comparison at 5 ~ 15 kr and 20 kr/hr. Fast neutrons at 24 ~ 125 rad were not markedly effective in inhibiting seed germination and seedling growth and decreasing survival in the field or seed fertility in X_1, but were for chlorophyll mutation effective even at 75 ~ 125 rad. It is assumed that these neutrons are more effective than 14 MeV neutrons, and the RBE value for chlorophyll mutation frequency is about 40 against γ-rays.

2. γ-rays and fission neutrons in the polyploid wheat series

Dry seeds of *Triticum monococcum flavescens*, *T. durum Reichenbachii* and *T. vulgare erythrospermum* were subjected on Oct. 21, 1963 to fission neutrons from the ORNL Health Physics Research Reactor, and γ irradiation from ^{60}Co source was also carried out simultaneously in Oak Ridge National Laboratory by courtesy of Dr. J. A. AUXER. Intensity of γ-rays in this series was 175 kr/hr. Neutrons were given for 804 seconds to the seeds at various distances from the center of the neutron reactor. The seeds of *T. monococcum* received doses of 103 ~ 1,027 rad and those of *T. durum* and *T. vulgare* doses of 257 ~ 2,057 rad. There was approximately 10 % additional exposure due to γ-rays associated with the neutron field.

The data for germination, seedling growth and seed fertility are given for fission neutrons and γ-radiation in Table 1. In June (harvest season) of 1963 we had unusually abundant rainfall. Therefore the seeds were not good and germination was generally low. The higher was the dose of fission neutrons and γ-rays, the more delayed were germination and growth of seedlings, and the more reduced was seed fertility. In general, *T. monococcum* was the most sensitive to fission neutrons and γ-rays. There was as expected no significant difference between *T. durum* and *T. vulgare*. The frequency of spike progenies with chlorophyll mutations in X_2 was also investigated, as shown in the last column of Table 1. As expected, the higher was ploidy, the lower was mutation frequency. Only one albina mutation was found in hexaploids.

The RBE values of different characters were calculated roughly from Table 1. For seedling height the RBE value of fission neutrons to that of γ-rays was found to

Table 1. Effects of fission neutrons and γ-rays on germination, seedling growth, fertility and mutation in wheat

Species	Dose	Germination rate (%)	Seedlings length (cm)	(Index)	Seed fertility (%)	Chlorophyll mutation rate (%)
T. monococcum flavescens (n=7)	Control	63	9.26	(100.0)	92.24	0.00
	N- 103 rad	58	9.93	(107.2)	80.04	3.04
	N- 257	59	6.81	(73.5)	74.00	6.52
	N- 514	63	4.98	(53.8)	56.38	11.07
	N- 770	39	5.97	(64.5)	43.51	9.60
	N-1027	40	3.50	(37.8)	41.71	17.19
	γ- 5 kr	59	6.71	(72.5)	58.99	5.22
	γ-10	52	5.18	(55.9)	34.51	8.38
	γ-15	42	2.96	(32.0)	34.33	7.58
T. durum Reichenbachii (n=14)	Control	72	7.67	(100.0)	90.97	0.00
	N- 257 rad	54	7.61	(99.2)	81.67	2.54
	N- 514	70	8.37	(109.1)	76.91	3.25
	N-1027	24	6.41	(83.6)	64.95	10.87
	N-1543	30	5.13	(66.9)	55.57	7.14
	N-2057	32	4.73	(61.7)	30.17	23.81
	γ-10 kr	36	6.70	(87.4)	85.77	0.00
	γ-17.5	28	5.14	(67.0)	82.76	0.00
	γ-25	24	4.82	(62.8)	74.96	14.29
T. vulgare erythrospermum (n=21)	Control	96	15.24	(100.0)	73.71	0.00
	N- 257 rad	88	14.46	(94.9)	69.17	0.00
	N- 514	88	13.30	(87.3)	60.10	0.00
	N-1027	86	10.51	(67.0)	47.79	0.24
	N-1543	92	9.86	(64.7)	26.22	0.00
	N-2057	80	5.96	(39.1)	14.08	0.00
	γ-10 kr	86	13.73	(90.1)	70.46	0.00
	γ-17.5	88	11.09	(72.8)	69.53	0.00
	γ-25	86	6.08	(39.9)	63.10	0.00

be 10 ~ 15. It was calculated for seed fertility as about 10 for diploids and as about 50 for tetra- and hexaploids and also for chlorophyll mutation as 25 or more in di- and tetraploids. In general, the RBE value was lower for the characters observed in earlier stages than at maturity, especially in polyploids.

3. γ-rays and 14 MeV neutrons on einkorn wheat

Dry seeds of *Triticum monococcum* were exposed in August 1963 to mono-energetic 14 MeV neutrons from $T(d, n)$ reaction neutron generator in the Hiroshima University by courtesy of Dr. H. YOSHINAGA. The neutron intensity was 9×10^9 neutrons/sec on average for 94 ~ 281 min, excluding γ-ray contamination of less than 10 per cent. For comparison γ-ray exposure was carried out simultaneously with 3.1 kr/hr for 102~510 min with the 6,000 curie ^{137}Cs source in our institute.

Germination, survival in the field, seed fertility and chlorophyll mutation were investigated. The results of the present experiment are roughly in good accord with those of our earlier works (MATSUMURA 1961, 1964) with 14 MeV neutrons obtained from ^3H (d, n) ^4He reaction produced in the 250 kV Cockcroft–Walton accelerator in the Biology Division, Oak Ridge National Laboratory. The data summed up from both experiments are given in Table 2. The RBE of 14 MeV neutrons to that of γ-

Table 2. Effects of 14 MeV neutrons and γ- or X-rays on germination, seedling growth, fertility and mutation in einkorn wheat

Dose	Germination (Index)	Seedlings length (Index)	Survival (Index)	Seed fertility (Index)	Chlorophyll mutation rate (%)
Control	100.0	100.0	100.0	100.0	0.00
N-0.5 krad	99.1	87.6	87.3	63.0	4.68
N-1.0	95.0	63.1	80.8	56.0	14.36
N-1.5	87.3	42.7	61.3	26.4	5.48
N-2.0	74.2	24.7	2.1	8.6	–
N-2.5	74.0	6.6	0.0	–	–
γ-5 kr	108.1	90.6	89.1	76.2	4.00
γ- or X-10	92.3	76.6	82.4	61.8	6.98
γ-15	83.8	53.9	86.7	56.8	4.81
γ- or X-20	64.8	28.4	4.9	64.2	9.30

and X-rays was calculated from the table. It was found to be abont 10 for germination rate showing a 10 % depression as compared with the control and about 13 for seedling height showing a 25 % depression. Also the RBE value was calculated as about 15 for seed fertility showing a 30 % depression and for chlorophyll mutation rate amounting to 5 %. It was generally lower for characters observed in earlier than in later stages, at maturity.

According to the above mentioned experiments with fission and fast neutrons from Po-Be, it is assumed that they are more effective than 14 MeV neutrons, and also that fast neutrons (Po-Be) are clearly the most effective. In general, the RBE of fast neutrons is clearly larger for higher plants than for animals and microorganisms, and it increases with increasing LET (linear energy transfer). The extraordinary large RBE values for mutations in higher plants strongly indicate, as also other evidences do (STADLER 1932, 1954, MATSUMURA *et al.* 1963, KONDO 1964), that the majority of ionizing - radiation induced mutations are due to chromosome aberrations or gross deletions.

Effects of 14 MeV neutrons in *T. monococcum*

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F_1 seeds from the cross between the normal type and a chlorina mutant were subjected to γ-rays and 14 MeV neutrons, as in the previous experiment (cf. Ann. Rep. Nos. 17, 18). 8,600 rad of γ-rays and up to 900 rad of neutrons had no apparent effect on germination rate. Survival rate in the γ-ray lot was slightly lower and was in the three neutron lots slowly decreasing with increasing dosage. A similar tendency was also observed in the average number of tillers, but it was not marked.

Somatic mutation rate was calculated on spike basis. As shown in Table 1, the frequency of tillers with chlorina stripes increased with increasing neutron dosage. The frequency of mutated tillers in the highest dosage lot was 0.79%; it was twice as large as that of the lowest dosage lot, and that of 8,600 rad of γ-rays was about one half as large as that of the 324 rad neutron lot. An almost linear relation was observed between mutation frequency and neutron dosage, but the mutation rate at higher dosages was too high for linear relation in the γ-irradiation experiments. From the result, we may say that somatic mutation is caused, for the most part, by chromosome aberrations.

Decrease of fertility was marked with increasing dosage. When the fertility was compared between mutated and non-mutated tillers within each individual, average fertility of the former was lower than that of the latter. These facts also support the view that most of somatic mutation arise from chromosome aberrations.

Average number of mutated tillers per individual roughly increased with increasing dosage, as the result of repeated occurrence of the same kind of mutation within the same individual.

Table 1. Frequency of somatic mutations

Treatment (krad)	No. of seeds	Germination rate (%)	Survival rate (%)	Total No. of spikes	Average No. of spikes per plant	Chlorina stripes	
						No. of plants	No. of spikes (%)
Control	239	44.8	87.9	3,228	34.3	0	
γ-8600	400	50.2	83.2	6,101	35.3	6	11 (0.18)
n-324	399	50.6	77.2	5.617	36.0	13	22 (0.39)
n-661	399	50.1	76.2	4,806	31.6	11	25 (0.52)
n-900	399	43.6	73.0	3,902	30.7	11	31 (0.79)

Effects of temperature on postirradiation storage in einkorn wheat

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It is well known that post-irradiation storage increases radiation damage in X- or γ-irradiated seeds, especially in super dry seeds (4~8%). Recently, Matsumura *et al.* (1961) reported that chronic irradiation was more effective in producing radiation damage than actue treatment in dry seeds of upland rice. However, they could not find such a relationship in seeds of einkorn wheat. An experiment was carried out to test whether or not a storage effect exists during chronic irradiation of seeds of einkorn wheat.

Dry seeds of einkorn wheat were irradiated with 10 and 15 kr γ-rays at acute dose rate of 10 kr/hr and stored in constant temperatures of 0°C, 13°C and 30°C for 436 hours. Furthermore, some of the treated seeds with 15 kr were also preserved at

Table 1. Relation between postirradiation temperature and radiation damage

Dose (kr)	Storage (hes)	Temperature (°C)	Seedling height (cm) (Index)	Seed fertility (%) (Index)
0	–	13	9.4 (100.0)	72.1 (100.0)
10	436	0	9.3 (98.9)	66.5 (92.2)
"	"	13	8.8 (93.6)	65.6 (90.9)
"	"	30	8.6 (91.4)	60.1 (83.3)
"	"	13	9.2 (97.8)	66.3 (91.9)
15	700	13	6.7 (71.2)	51.5 (71.4)
"	436	0	8.4 (89.3)	58.5 (81.1)
"	"	13	7.1 (75.5)	49.1 (68.0)
"	"	30	7.0 (74.4)	48.6 (67.4)
"	138	13	7.7 (81.9)	57.9 (80.3)
"	0	13	7.8 (82.9)	63.1 (87.5)

13°C for 138 and 700 hours. All treated seeds were sown almost simultaneously, just after storage. The data for seedling height and seed fertility in the X_1-generation are shown in the table.

There was found a slight radiation damage in acute 10 kr irradiation. The seedling height and seed fertility were significantly reduced with prolongation of storage, when the irradiated seeds were stored at 13°C after 15 kr irradiation. The results show that there was a clear storage effect.

There was also a clear storage effect on seedling growth and seed fertility of γ-irradiated seeds, stored at 13°C and 30°C for 436 hours after 15 kr irradiation but no clear storage effect was found in seeds, stored at 0°C for 436 hours.

The results of this experiment show that storage effect was greatly influenced by irradiation dose, temperature and storage duration. It is therefore considered that storage effect is noticeable if seeds are irradiated chronically, but the effect may be often masked due to modifying factors *i. e.* temperature or water content.

Oxygen and storage effects on radiation damage in einkorn wheat seed

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Dry seeds of *Triticum monococcum flavenscens* containing 13% water were sealed in ampules filled with oxygen, nitrogen and air, and exposed to 10 and 15 kr γ-rays. For acute and chronic irradiation dose rates of 10,000 r/hr with ^{137}Cs and 19.7 r/hr with ^{60}Co were used, respectively. Two chronic irradiations (10 and 15 kr) were terminated simultaneously before sowing. Acute irradiations were given at the time coinciding with the beginning and termination of the chronic ones. The inhibition of seedling growth was investigated. In general, chronic irradiations were found to be more effective than acute ones, especially at higher irradiation with 15 kr. There were no clear differences between air and oxygen treatment either in acute or chronic irradiation. On the other hand, nitrogen treatments clearly showed a protective effect on the inhibition of seedling growth, especially in acute irradiations. Unexpectedly, post-irradiation storage had no effect on the inhibition, also in acute irradiations.

These results might be explained by the relationship between the production and decay of free radicals and radiation damage. It is assumed that nitrogen treatment decreases the radical yield, and the production and decay of the radicals are more gradual and slower in chronic than in acute irradiation.

Effect of gamma-radiation on germination and survival in some bread wheat varieties

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As an attempt to improve their characteristics by inducing mutations with radiation, six varieties from different parts of India were treated with gamma-rays at Cobalt-60 facility installed at the International Agriculture Fair held at New Delhi in 1959~60. Application of variable doses of gamma-rays to seeds of these varieties has lead the author to some interesting findings in the first generation of the treatments. These results mainly point out the behaviour of the treated seeds along with the controls encountered in germination and survival studies of varieties R. S. 31-1, R. S. 9-11, Malvi Ekdania (*durum*), Jaipur Local and Kharchia. The seeds were germinated in laboratory in petridishes lined with water soaked filter papers, and the observation was made on forth, sixth and eighth day after sowing. The data are given in the Table 1.

Apparently there was a general decline in growth of radicle and plumule in the treatments and more so in the higher doses when compared to the controls. On the fourth day controls of various varieties showed difference in rate of growth of radicle and in the rate of growth of plumule, this rate being faster in Kharchia than in R. S. 9-11, R. S. 31-1 and Jaipur Local. Kharchia was showing the emergence of highest number of secondary roots (3~4) on this day in the 10,000r treatment. All the rest of the treatments were showing only two secondary roots each and the controls had a range of 2~4 such roots (Table 1). Highest number of secondary roots among the controls emerged also from Kharchia. Next in this respect was Malvi Ekdania (*durum*) having 2~3 secondary roots in the 30,000r treatment on this day.

On the sixth day (Table 1) in the 10,000r treatment Malvi Ekdania and Kharchia showed the highest length of radicle and plumule and also highest length of secondary roots. In the 20,000r treatment Kharchia had the highest length of radicle and R. S. 31-1 and Malvi Ekdania were equal in this respect. Length of plumule was highest in Kharchia and Malvi Ekdania. In the 30,000r treatment highest length of radicle was shown by Jaipur Local and Malvi Ekdania and same holds good for plumule length also. In the controls the highest length of radicle was shown by Khar-

Table 1. Showing growth at germination in the six varieties of wheat irradiated with gamma-rays and their controls

Day of observation and material	Treatments															
	Control				10,000r				20,000r				30,000r			
	1	2	3a	3b	1	2	3a	3b	1	2	3a	3b	1	2	3a	3b
Fourth day:																
Kharchia	4.2	3.5	4	–	2.0	2.2	4	–	3.0	3.0	2	–	2.2	2.0	2	–
Jaipur Local	3.5	2.5	3	–	1.0	1.0	2	–	1.3	1.2	2	–	1.2	1.0	2	–
R. S. 9-11	3.5	2.2	3	–	2.0	1.4	2	–	2.0	1.3	2	–	1.5	1.1	2	–
C. 591	3.0	1.0	3	–	1.5	0.5	2	–	1.3	1.1	2	–	1.0	0.6	2	–
R. S. 31-1	4.0	3.5	2	–	1.5	0.7	2	–	1.0	0.6	2	–	1.0	1.5	2	–
Malvi Ekdania	2.5	2.5	3	–	3.0	1.5	2	–	1.3	1.7	2	–	2.0	2.0	3	–
Sixth day:																
Kharchia	7.0	6.0	4	5.0	2.7	4.0	4	1.7	3.7	3.0	3	2.0	2.6	3.0	3	2.0
Jaipur Local	5.0	5.5	4	3.0	2.0	2.5	3	1.0	1.5	2.5	4	2.0	2.2	3.5	4	2.5
R. S. 9-11	6.0	5.3	4	4.5	2.5	2.7	3	2.0	2.5	2.0	3	1.5	2.0	3.0	3	1.5
C. 591	5.5	4.0	3	3.5	2.0	1.7	4	2.0	2.2	2.5	3	2.0	1.3	1.2	4	1.2
R. S. 31-1	6.0	5.0	3	6.0	1.5	1.6	3	1.5	1.5	1.2	3	2.0	1.3	2.0	3	1.0
Malvi Ekdania	4.0	5.0	5	5.0	3.5	3.5	4	3.4	2.5	4.0	4	2.5	3.2	4.5	3	3.0
Eighth day:																
Kharchia	13.5	10.5*	6	12.5	4.5	4.5*	5	4.0	3.0	8.0	5	5.0	2.8	4.5	3	2.5
Jaipur Local	7.5	8.5*	5	8.0	3.0	5.0	4	2.5	2.5	4.0*	4	2.5	3.5	4.5*	5	3.0
R. S. 9-11	8.0	8.5*	5	6.0	4.2	7.0*	4	3.0	3.0	4.5	4	2.5	2.6	6.5*	5	2.0
C. 591	7.0	8.5*	5	9.0	2.5	4.5	5	3.0	2.5	4.0	4	2.0	1.5	3.5	4	1.2
R. S. 31-1	8.0	8.5*	4	11.0	2.0	4.5	4	2.0	1.8	3.5	3	1.0	1.2	4.0	4	1.0
Malvi Ekdania	5.5	8.5*	5	9.0	6.0	8.0*	4	5.0	4.0	7.0*	4	3.0	3.0	6.0	4	3.5

N. B. 1: Length of radicle in cm. 2: Length of plumule in cm. 3a and 3b: Number and average length in cm. respectively of the secondary roots.
First leaf appeared in the treatment marked *.

chia followed by R. S. 9–11 and R. S. 31–1 and in case of plumule Kharchia was leading followed by Jaipur Local and R. S. 9–11. Highest number of secondary roots were shown in 10,000r treatment by Jaipur Local and Malvi Ekdania and in 30,000r treatment by Jaipur Local and C. 591. On this day color of plumule, which had just emerged in these varieties was also observed. It was revealed that Jaipur Local and R. S. 31–1 both had green plumules while R. S. 9–11, and Malvi Ekdania all had white plumules and Kharchia had pink one. This is just the same for controls also.

On the eighth day (Table 1) first leaf appeared in a few of the treatments viz. 10,000r treatments of Kharchia, R. S. 9–11 and Malvi Ekdania; 20,000r treatment of Jaipur Local and Malvi Ekdania and in 30,000r treatment of Jaipur Local and R. S. 9–11. On this day all the controls had the first leaf appeared.

On the twelfth day some of the seedlings showed signs of degeneration. The various treatments were observed for vegetative growth in respect to the number of leaves in each treatment. In all the treatments Kharchia seemed to maintain the vigour as before. In 30,000r treatment next best were Malvi Ekdania and Jaipur Local. If all treatments be taken together, C. 591 was the earliest to show cessation of growth activity followed by R. S. 31–1. In these varieties appearance of a reduced stem and the radicle was followed by more or less substantial necrosis which soon killed the young plants.

In conclusion, treatment of a diploid wheat, Malvi Ekdania was showing the best germination and survival in all the treatments as compared to the rest of the hexaploid wheat varieties during the plant germination stage. Among hexaploid wheats Kharchia showed best resistance to the ill effects of irradiation at this stage. This indicates that the effects of irradiation depends greatly upon the physical and biological properties of the material in consideration.

These results showed that different varieties are differently susceptible to irradiation and may also show these differences in different phases of plant development.

Also as many of the induced mutations in bread wheats are chromosomal in origin, the increase in the amount of chromosomal damage induced by gamma-rays appears to be the cause for lower germination activity and survivals since the occurence of too many chromosomal structural changes might lead to disturbed conditions in the life cycle of plant material under consideration.

Awn inhibitor in Redman wheat

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Based on the F_1 data of a series of crosses, Redman monosomics × Prelude, Campbell and McGinnis (1958) concluded that a common wheat variety, Redman, carries two complementary genes for awn suppression on the chromosomes 5A (formerly IX) and 1D (XVII). One of them located on chromosome 5A seems to be an allele of B_1 gene. The other gene on chromosome 1D was designated as B_8 by Tsunewaki and Jenkins (1961).

In an attempt to establish isogenic marker lines in another common wheat variety, S-615, B_8 has been chosen as a marker gene for chromosome 1D. In the course of transferring this gene from Redman to S-615, however, it was unexpectedly found that Redman carries only a single dominant gene instead of two complementary genes. Therefore, a further investigation has been made in order to reveal the gene system for awnlessness of Redman wheat.

Redman and two other awnless varieties, Elgin and Jones Fife, which are known to carry only the B_1 gene, were crossed to two awned varieties, Prelude and S-615. Data on the F_2 segregation of those crosses are summarized in Table 1. Actual segregation ratios of all six crosses fitted the 1 : 3 ratio, disproving the 7 : 9 ratio of awned vs. awnless.

Mono-5A of Redman, whose seeds were kindly supplied by Dr. R. C. McGinnis, was crossed to S-615 as male parent. In the F_1 generation, a cytological examination was made in order to distinguish disomic and monosomic hybrids. Their selfed progenies were tested for the segregation of awn types. Similarly to the result of Campbell and McGinnis (1958), all disomic F_1 plants were awnless, while F_1 mono-5A's were all awned. In the F_2 generation of the disomics, however, 1 : 3 ratio of awned vs. awnless was obtained instead of 7 : 9 ratio expected from segregation of two complementary genes. No awnless plants were found in the offspring of F_1 mono-5A.

From these results it can be said that the gene system for awnlessness of Redman is not different from that of Elgin and Jones Fife, indicating only one dominant inhibitor, B_1. Person (1956) has already pointed out that univalent shifts and other cytological changes may occur in monosomics due to occasional meiotic irregularities. Therefore, it is necessary to carry out a monosomic analysis, at least, to the F_2 generation and compare the F_1 record with the segregation data in F_2. By such procedures a wrong conculsion due to occasional cytological change that occurred in a certain monosomic line may be avoided.

Table 1. F_2 data for awnedness of six crosses between awnless and awned varieties of common wheat

Cross combination (awnless × awned)	Number of plants			χ^2	
	Total	Awned	Awnless	1 : 3	7 : 9
Redman × Prelude	189	50	139	0.21	22.98*
〃 × S-615	89	25	64	0.45	8.87*
Elgin × Prelude	379	92	287	0.11	58.41*
〃 × S-615	440	106	334	0.19	69.10*
Jones Fife × Prelude	70	17	53	0.02	10.78*
〃 × S-615	428	115	313	0.80	49.56*

* Significant at the 1% level.

The frequency of twin seedlings in New Zealand wheats

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In the course of a project to obtain heteroploid plants in New Zealand bread wheat varieties, information on the frequency of twin seedlings in these varieties was collected. Wilson and Ross (1) reported recently that in three varieties of winter wheat a twin pair was found per 3,786 seedlings examined. Earlier Muentzing (2) obtained a large number of wheat twin pairs, but did not give details of their frequency. Kihara and Tsunewaki (3) found one per 1,569 seedlings in normal wheats.

In this study five New Zealand commercial varieties and two unnamed hybrid lines were examined, four of them over three consecutive seasons and three for two

Table 1. Frequency of twin seedlings in New Zealand wheats

Variety of hybrid line		Aotea	650,01	Cross 7-61	Hilgendorf -61	Arawa	705,01	Gabo	Total
1962~1963	Number of twin pairs	21*	–	–	11	74	41*	–	147
	Seedlings per twin pair	2,359	–	–	3,790	670	1,223	–	8,042
1963~1964	Number of twin pairs	2	17	2	3	31	14	41	110
	Seedlings per twin pair	12,899	1,715	10,051	8,949	670	1,587	512	36,383
1964~1965	Number of twin pairs	2	7	0	0	20	10	33	72
	Seedlings per twin pair	10,713	3,141	–	–	1,173	2,421	733	18,181
Total	Number of twin pairs	25	24	2	14	125	65	74	329
	Seedlings per twin pair	3,871	2,131	21,132	6,547	750	1,485	610	36,526

* includes one triplet.

seasons. The seed lines were obtained each year from autumn-sown field tria's grown near Lincoln, with the exception of the seed of the variety Gabo which came from spring-sown increase blocks in the same district. Weighed or counted samples were germinated on wet paper towels in a germinating cabinet maintained between 75° and 80°F. Seedlings were removed for examination daily and the number of ungerminated grains was deducted from the total after a week of germination. In the three seasons over 500,000 seedlings were examined and 327 twin pairs and two triplets were found; in addition five twins of these varieties were obtained from other sources. The results in Table 1 were examined in several chi-square tests and show that there were substantial varietal differences in the frequency of twin seedlings and highly significant season-to-season variation.

The seedlings of a twin pair were generally dissimilar in size, the smaller being displaced to on side of the major seedling. Twin pairs were classified into three groups on the size relations of the component seedlings (Table 2). The number of twin pairs studied was not large enough to determine differences between varieties in the relative size of the seedlings, except that the difference betwcen Gabo and all the others was very highly significant, (chi-square 13 4 with 1 d.f.). The smaller seedling was displaced to either side of the major embryo with approximately equal frequency (134 and 148).

There appeared to be no relationship between seed-size, a: determined by 1,000

Table 2. Size relations of seedlings of twin pairs

Variety or hybrid line	Percentage of twin pairs in size groups			Number of twin pairs
	Small	Sub-equal	± Equal	
Aotea	46	35	19	26
650,01	54	42	4	24
Cross 7-61	100	0	0	2
Hilgendorf-61	20	73	7	15
Arawa	48	46	6	128
705,01	41	50	9	64
Gabo	20	66	14	73
Average and Total	40.1	50.9	9.0	332

kernel weight determinations, and frequency of twins (Table 3). The variety Gabo was used to investigate the possibility of recognising ungerminated grain with twin embryos. A sample of 3,000 grains classed as normal yielded four twin pairs, whiel 85 grains apparently with slight morphological abnormalities of the embryo, which had been selected from the same sample, did not produce any twins.

It is concluded that the frequency of twin seedlings is a varietal characteristic under the influence of environmental conditions and not related to the average grain size of the variety. Grains with twin embryos could not be recognised by visual examination of ungerminated kernels.

Table 3. Relationship between frequency of twin pairs and grain size

Frequency of twin pairs	Variety or hybrid line	1,000 Kernel weight in gm, 1964~65
High	Gabo Arawa	49.3 52.4
Moderate	705,01 650,01	57.4 47.9
Low	Aotea Hilgendorf - 61 Cross 7 - 61	48.4 53.2 43.8

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Monosomic analysis of adult plant resistance to black rust in the wheat variety Yaqui-53

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In the present studies, urediospore suspension was used for creating the artificial epidemics. The races included were 15, 21, 21A, 24, 34, 40, 42 and 117 of black rust. The mode of inheritance of field resistance to black rust in the cross of Chinese Spring monosomics with Yaqui—53 resistant parent) indicated the presence of two dominant duplicate factor pairs on chromosome 3A and 6B (Table 1). These findings got confirmation in the normal cross (Chinese Spring × Yaqui—53), where resistance was dominant and a segregation ratio of 15 resistant : 1 susceptible was clearly established. The presence of resistant plants in monosomics 3A and 6B and their reaction indicated, that almost the same type of resistance is shown in these two 'critical' lines. These results suggest that the resistant variety, Yaqui—53, carries two pairs of dominant genes for resistance viz., R_1R_1 and R_2R_2, and the susceptible parent Chinese Spring, corresponding alleles r_1r_1 and r_2r_2. The presence of comparatively more semi-resistant and susceptible plants in line 7A, may be due to the presence of some minor gene for susceptibility, which may be incapable of expressing itself fully in the presence of dominant genes for resistance or may exert some other modifying action.

Nyquist (1957) showed that the resistance of variety C. 1. 12633 is controlled by duplicate dominant linked genes, (21 cross-over units apart) for stem rust resistance located on chromosome 2B. Campbell and McGinnis (1958), using the monosomic series of Redman Spring Wheat in crosses with Prelude, reported that chromosomes 2B, 3B and 4B of Redman carry factors for adult plant resistance to race 56. Kritzinger (1962) by monosomic analysis of *Triticum vulgare* varieties, Montana, Kenya Supremo, Kenya Farmer and Timstein indicated that genes for resistence are located on chromosomes 3A, 5A, 2B and 4D respectively. Thus, different workers noted the reaction to stem rust in the adult stage to be conditioned by one or more factors, but by far maximum support has been given for the operation of two factor pairs.

Sears (1962) and subsequent studies by Loegering and Sears 1963) demonstrated the presence of a pollen killing gene on chromosome 6B. The pollen fertility of Yaqui—53 and monosomic 6B cross along with normal Chinese Spring gave no indica-

Table 1. Adult plant resistance to black rust (Chinese monosomics × Yaqui-53-F_2)

Mode : 15R : 1S

Material	No. of resistant plants	No. of semi-resistant plants	Total No. of resistant plants	No. of susceptible plants	Total No. of plants	X^2	P-value
Chinese Spring (Normal)	-	-	-	71	71	-	-
Yaqui-53 (male)	82	23	105	-	105	-	-
Chinese Normal × Yaqui-53	38	97	135	11	146	0.423	.70~.50
1A × Yaqui-53	37	106	143	15	158	2.9415	.10~.05
2A × "	56	102	158	12	70	0.896	.20~.50
3A × "	97	49	146	1	147	'Critical line'	
4A × "	47	97	144	18	158	1.8425	.20~.10
5A × "	41	103	144	16	160	3.84	.05
6A × "	32	102	134	14	148	2.6702	.20~.10
7A × "	32	98	130	21	151	(More susceptible plants)	
1B × "	52	87	139	13	152	1.3753	.30~.20
2B × "	42	89	131	16	147	5.577	.02~.01
3B × "	67	77	144	12	156	0.581	.50~.30
4B × "	37	99	136	13	149	1.5699	.30-.20
5B × "	52	83	135	11	146	0.423	.70~.50
6B × "	102	33	135	1	136	'Critical line'	
7B × "	72	47	119	9	128	0.133	.80~.70
1D × "	41	102	143	12	155	0.5927	.50~.30
2D × "	34	92	126	12	138	1.4334	.30~.20
4D × "	45	88	133	11	144	0.4740	.50~.30
5D × "	34	101	135	9	144		.99~
6D × "	34	92	126	12	138	1.4334	.30~.20
7D × "	43	121	164	14	178	0.7925	.50~.30

Remark: Chinese Spring mono. 3D × Yaqui-53 F_2 seeds were not available.

tion of sterility, which demonstrates that there may be another allele at *Ki* locus on chromosome 6B of Yaqui—53.

Resistance of Yaqui—53 is contributed by the wheat varieties Hope, Thatcher and Kenya. The resistance of Hope was observed by several workers to be governed by two pairs of factors CLARK and AUSEMUS 1928, NEATBY and GOULDEN 1930, HAYES *et al.* 1934). SEARS *et al.* (1957) reported that genes for adult plant resistance to stem rust are carried on chromosome 3B and 1D in the variety Hope. For resistance of Thatcher, they reported two genes on chromosome 3B and 2B. In the present study, genes for adult plant resistance to stem rust were identified on chromosome 3A and 6B, which are different from these reports (Table 1). This may be due to the resistance in this case being contributed by the third parent, Kenya wheat, or this could be due to different types of interaction involved in the host pathogen relationship, the precise nature of which needs further study. POKHRIYAL (1960, unpublished) observed that Yaqui—53 carries to pairs of dominant duplicate factors for resistance to stem rust. These observations are further confirmed by our results, where by monosomic analysis it has been established that genes for resistance are present in chromosome 3A and 6B of Yaqui—53.

Intergeneric hybrids between two *Eremopyrum* and *Agropyron* species

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The following three intergeneric pentaploid hybrids were produced in 1964: (1) *Er. buonapartis* (SPRENG.) NEVSKI var. *buonapartis* (2n=28; Iran) × *Ag. tsukushiense* (HONDA) OHWI (2n=42; Japan), (2) *Er. buonapartis* var. *sublanuginosum* (DROB.) MELDERIS (2n=28; Afghanistan) × *Ag. tsukushiense* and (3) *Er. orientale* (LINN.) TAUB. *et* SPACH. (2n=28; Iran) × *Ag. tsukushiense*.

All F_1 plants were perennial, and the shape of their spikes and spikelets was of *Agropyron* type. Complete pollen sterility was observed in all hybrid combinations. Choromosome pairing at MI of PMC's of the F_1 is shown in Table 1. Average chromosome pairing per cell was in (1) $0.0_{III}+0.7_{II}+33.6_{I}$, in (2) $0.8_{II}+33.5_{I}$ and in (3) $0.9_{II}+34.0_{I}$. Bivalents and trivalents were all loosely associated the partners connected only terminally. It was concluded that there is no genomic homology between the two *Eremopyrum* species and *Ag. tsukushiense*.

Fifteen backcrossed plants were obtained when *Ag. tsukushiense* was crossed as male parent to the third hybrid, *Er. orientale* × *Ag. tsukushiense*. To its tillering clones colchicine solution was applied and two well-developed seeds were obtained in 1965.

Table 1. Chromosome pairing in the PMC's of the F_1 hybrids *Er. buonapartis* and *Er. orientale* × *Ag. tsukushiense*

Chromosome pairing			Number of cells observed		
III	II	I	*Er. buonapartis* var. *buonapartis* × *Ag. tsukushiense*	*Er. buonapartis* var. *sublanuginosum* × *Ag. tskushiense*	*Er. orientale* × *Ag. tsukushiense*
		35	338	177	1,049
	1	33	203	97	421
	2	31	81	48	138
	3	29	16	14	34
	4	27	6	5	2
	5	25	1		
1	1	30	1		
1	2	28	1		
Total			647	341	1,644

Determination of species relationships in the genus *Agropyron* by interspecific hybridization and genome analysis [1)]

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Cytogenetic study of 6 interspecific *Agropyron* hybrids has provided further evidence for the world-wide distribution of genomes which seem to have common ancestry with the spicatum (S) genome. Modifications of the S genome were shown to be present in plants of 10 strains of 8 *Agropyron* species which are listed along with their accession numbers and seed sources in Table 1. Hybrids established and studied were: *A. subsecundum* × *A. latiglume*, *A. caninum* × *A. latiglume*, *A. arizonicum* × *A. caninum*, *A. caninum* × *A. riparium*, *A. brachyphyllum* × *A. riparium* and *A. semicostatum* × *A. trachycaulum*. Each of these hybrids were sterile with the exception of *A. caninum* × *A. latiglume* which was highly fertile.

Parent and hybrid plants were analyzed morphologically and cytologically. The average chromosome associations for the six newly established interspecific hybrids are listed in Table 2.

New genome formulas for *A. arizonicum*, *A. brachyphyllum*, *A. caninum*, *A. latiglume*, *A. riparium*, *A. semicostatum* (2n=28), *A. semicostatum* (2n=42), *A. subsecundum* and *A. trachycaulum* are proposed in Table 3 and compared with already published formulas. These formulas are based on evidence shown in Table 2, from evidence of earlier published hybridization results, and from earlier cytological and serological results obtained in the Montana laboratory. In 5 of the 6 hybrids, bivalent pairing ranged from 10.13 in *A. arizonicum* × *A. caninum* to 12.15 in *A. subsecundum* × *A. latiglume*. These data suggest close homologies of two basic genomes which were designated S and B (Table 3). Some authors have designated genome S with the letter A. But since a definite relationship has been established between this basic genome and the chromosomes of diploid *A. spicatum*, we prefer to call it S. The second basic genome B was assumed to be different from genome

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Table 1. Sources of plants of 10 strains of 8 *Agropyron* species used in interspecific crosses

Species	MSU field No.	Observed 2n	Seed Source 1)
A. arizonicum SCRIBN. *et* SMITH	2–5	28	Received from seed collection of the Institut für Pflanzenbau und Pflanzenzüchtung Göttingen, Germany, in January 1960 as field Nos. 52-1957 and 165-1958. MONT 59,277.
A. brachyphllum BOISS. *et* HAUSSK.	3–1	42	Collected by H. S. GENTRY, east base of Kuhe Zard, Charmahal Iran, Nov. 9, 1955. P.I. 229,912. MONT 59,278.
A. caninum (L.) BEAUV.	6–3 6–4 6–5	28 28 28	Seed from Botanic Gardens, Budapest, Hungary via Gatersleben, Germany. Received through Institut für Pflanzenbau und Pflanzenzüchtung, Göttingen, Germany, in January 1960 as field Nos. 4-1957 and 131-1958. MONT 59,279.
A. latiglume (SCRIBN. *et* SMITH) RYDB.	47–3	28	Colleted by F. J. HERMANN and B. M. LEESE, at Sentinal Peak, Coleman, Kananaskes Road, Canada, 1956. P. I. 236,637. MONT 59,309.
	48–2	28	Collected by F. J. HERMANN and B. M. LEESE at Middle Fork of Sheeps Creek on road to Spirit Lake (Ashley National Forest) Daggett Co., Utah, at 9,000 ft. elevation, in Lodgepole Pine meadow during July to Sept. 1955. P. I. 232,117. MONT 59,310.
A. riparium SCRIBN. *et* SMITH	62–2	28	Received from seed collection of the Institut für Pflanzenbau und Pflanzenzüchtung, Göttingen, Germany, in January 1960 as field Nos. 60-1957 and 171-1958. MONT 59,317.
	62a–4	28	Collected by R. G. JOHNSON as *A. smithii* RYDB. near Canyon City, Grant Co., Oregon in area of 12 inches annual rainfall at elevation of 3,000 ft. in 1933. P-2415. Variety "Sodar". MONT 59,321.
A. semicostatum (STEUD.) NEES	65–4	28	Received from seed collection of Institut für Pflanzenbau und Pflanzenzüchtung, Göttingen, Germany, January 1960, as field Nos. 59-1957 and 170-1958. MONT 59,321
A. subsecundum (LINK) HITCH.	65–1	28	Received from seed collection of Institut für Pflanzenbau und Pflanzenzüchtung, Göttingen, Germany, January 1960, as field Nos. 59-1957 and 170-1958.
A. trachycaulum (LINK) MALTE.	93–2	28	Collected by USDA Forest Service near Beebe, Montana, 1933. Variety "Primar". P-2535. MONT. 59,338.

1) MONT = Herbarium of Montana State University, Bozeman, Montana, U.S.A.

P = Seed collection of the U.S.D.A. Soil Conservation Service, Pacific Region, Plant Material Center, Washington State University, Pullman, Washington.

P.I. = Seed collection of the U.S.A., A.R.S., New Crops Research Branch, Crops Research Division, Plant Introduction Stations, Western Region, Pullman, Washington, and North Central Region, Ames, Iowa.

S in earlier studies because tetraploid species in this group do not form quadrivalents in meiosis (for instance BOYLE 1963). We are not completely satisfied with this argument since genetic control of meiosis can lead to *meiotic diploidy* in autotetraploids with complete bivalent pairing and lack of quadrivalents. Only the discovery of a diploid which carries the B genome would completely answer the question of its origin. Since this diploid ancestor may not exist anymore, other biosystematic methods may help to clarify the true nature of ploidy in these tetraploids. However, we provisionally accept the present concept of alloploidy.

Table 2. Average metaphase I chromosome associations in 6 interspecific *Agropyron* hybrids

Hybrid	2n=	Average chromosome association per cell I	II	III	IV	V	VI
A. subsecundum × *A. latiglume*	28	0.66	12.15		0.75		
A. caninum × *A. latiglume*	28	3.69	12.10	0.03			
A. arizonicum × *A. caninum*	28	3.98	10.13	0.48	0.45	0.08	0.02
A. caninum × *A. riparium*	28	3.26	11.62	0.20	0.22	0.01	
A. brachyphyllum × *A. riparium*	35	7.13	10.28	1.99	0.22	0.02	0.04
A. semicostatum × *A. trachycaulum*	28	13.66	6.56	0.19	0.13	0.02	

A. trachycaulum was given the formula $S_1S_1B_1B_1$ in this study. One of the basic genomes of tetraploid *A. semicostatum* showed high pairing with one of the genomes of *A. trachycaulum* (6.56_{II}) which indicates close homology. SCHULZ-SCHAEFFER *et al.* (1963) found 2 pairs of an F-type *satellite indicator chromosome* in hexaploid *A. semicostatum* which suggested the presence of 4 spicatum genomes in this species. Consequently, hexaploid *A. semicostatum* should be an autoalloploid with the genome formula $S_1S_1S_1S_1YY$. If two genomes of the hexaploid are of the S_1 type, it is very likely that at least one genome of tetraploid *A. semicostatum* is an S_1 genome. Chromosomes of the second genome of tetraploid *A. semicostatum* did not pair with chromosomes of *A. trachycaulum*. The origin of this genome (Y) is unknown. For these reasons we gave tetraploid *A. semicostatum* the genome formula S_1S_1YY (Table 3).

A group of 3 species showed very close relationship. These were *A. subsecundum* ($S_2S_2B_2B_2$), *A. latiglume* ($S_2S_2B_2B_2$) and *A. caninum* ($S_2S_2B_2B_2$). Average bivalent pairing between these 3 species was 12.15 and 12.10, respectively. One of these 3 species, *A. caninum*, was crossed with *A. riparium* and *A. arizonicum*. Lower bivalent pairing was observed in both crosses averaging 11.62 and 10.13, respectively. Consequently, the genome formulas assigned were $S_8S_8B_8B_8$ (*A. riparium*) and $S_4S_4B_4B_4$ (*A. arizonicum*).

Table 3. Genome formulas for 9 strains of 8 *Agropyron* species derived from the analysis of 6 interspecific hybrids and indicator chromosome analysis

Species	2n	Published genome formulas	Author	New genome formulas
A. arizonicum	28			$S_4S_4B_4B_4$
A. brachyphyllum	42			$S_5S_5B_5B_5XX$
A. caninum	28	SSXX	(Cauderon 1958)	$S_2S_2B_2B_2$
A. latiglume	28	$A_2A_2B_2B_2$	(Collins 1965)	$S_2S_2B_2B_2$
A. riparium	28			$S_8S_8B_8B_8$
A. semicostatum	28			S_1S_1YY
A. semicostatum	42			$S_1S_1S_1S_1YY$
A. subsecundum	28			$S_2S_2B_2B_2$
A. trachycaulum	28	AABB	(Boyle & Holmgren 1955)	$S_1S_1B_1B_1$

Relatively low bivalent pairing (10.28) was found between the two basic genomes of *A. riparium* and two of the 3 genomes of *A. brachyphyllum*. The third genome (X) of *A. brachyphyllum* formed univalents (7.13_I) and could not be identified. The genome formula given for *A. brachyphyllum* was $S_5S_5B_5B_5XX$ (Table 2 and 3.)

Schulz-Schaeffer and Jurasits (1962) and Schulz-Schaeffer *et al.* (1963) in a study of *genome indicator chromosome*, theorized that all 8 species analyzed here carry the spicatum genome (*indicater chromosome* type F-1, F-2). This earlier hypothesis is substantiated by the data presented and by work of other authors.

Frequency and geographical distribution of rye with accessory chromosomes in Korea

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It is known that rye in Korea possesses very high frequency of accessory or B-chromosomes. Seeds of rye were collected from various localities in Korea in 1962 and 1963, and were grown in the experiment field. In the following springs, spikes were fixed in acetic alcohol with a trace of ferric chloride for the observation of meiosis in PMC. In addition, spikes were obtained from two rye fields directly.

The frequncy and geographical distribution of accessory chromosomes in Korean rye are shown in Figure on the cover and Table 1. The data are summarized as follows.

(1) 32 populations of rye investigated were found to contain plants with accessory chromosomes. The frequency ranged from 2 to 73.3% with 30~40% as the mode.

(2) In total, plants with two accessory chromosomes seem to be most stable among plants with accessory chromosomes in population as previously mentioned by Muentzing.

Table 1. Frequency of B-chromosomes in 32 population of rye in Korea

Population number	Locality	Number of plants with B-chromosomes 0	1	2	3	4	Total	Percentage of plants with B-chromosomes	Average number of B-chrs. per plant
0	Daejo-myun Kimhae-gun	21	1	4	-	1	27	22.2	0.48
1	Chinyong 1 Kimhae-gun	31	-	9	-	1	41	23.9	0.54
2	Chinyong 2 Kimhae-gun	22	-	14			36	38.9	0.78
3	Kochang 1	16	-	3	1		20	20.0	0.45
4	Kochang 2	18	-	7	1		26	30.8	0.65
5	Sanchung-myun 1	17	-	13			31	41.9	0.84
6	Sanchung-myun 2	24	1	13	-	1	39	38.5	0.79
7	Hapchon-myun 1	19	-	5			24	20.8	0.42
8	Hapchon-myun 2	20	-	13			33	39.4	0.79

Table 1. (continued)

9	Sangnam-myun 1 Miryang-gun	18	–	9			27	33.3	0.67
10	Sangnam-myun 2 Miryang-gun	41	1	9			51	19.6	0.37
12*	Paldang	49	–	1			50	2.0	0.04
13	Nam-myun Yangju-gun	9	1	3			13	30.8	0.54
14	Puyo	27	3	11	1		42	35.7	0.67
15	Sinnae-dong Seoul	35	–	15			50	30.0	0.60
16*	Paldang	46	–	4			50	8.0	0.16
17	Chonju 1	20	–	13	–	1	34	41.2	0.88
18	Chonju 2	26	–	14			40	35.0	0.70
19	Asan-myun Kochang-gun	23	3	21	–	1	48	52.1	1.02
20	Kosu-myun Kochang-gun	19	–	10	–	2	31	38.7	0.90
21	Yechon	8	4	14	–	4	30	73.3	1.6
22	Yongmun-myun Yechon-gun	17	1	16			34	50.0	0.97
23	Chonwon-gun	22	2	22	–	1	47	53.2	1.06
27	Andong-gun	19	1	25	–	2	47	59.6	1.26
30	Daehwa-myun 1	7	–	1			8	(12.5)	(0.25)
31	Chunsung-gun 1	32	–	6			38	15.8	0.32
33	Chunsung-gun 3	25	1	13	–	3	42	40.5	0.93
37	Kwangsan-gun	20	–	14	–	2	36	44.4	1.00
39	Daehwa-myun 2	18	–	3			21	14.2	0.29
40	Pangrim-myun Pyungchang-gun	27	–	10			37	27.0	0.54
41	Okgye-myun Myungju-gun	29	3	10			42	31.0	0.55
42	Songsang-myun Myungju-gun	10	–	1			21	4.8	0.10
32 populations Total		751	22	325	3	20	1,121		

*The No. 12 (Paldang in 1962) and No. 16 (Paldang in 1964) were collected from the same rye field.

II. News

KUSE Publications

The publications of the results of the Kyoto University Scientific Expedition to the Karakoram and Hindukush (KUSE), 1955, have been completed in the following eight volumes:

I. Cultivated Plants and their Relatives. Ed. by K. YAMASHITA
II. Flora of Afghanistan. Ed. by S. KITAMURA
III. Plants of West Pakistan and Afghanistan. Ed. by S. KITAMURA
IV. Insect Fauna of Afghanistan and Hindukush. Ed. by M. UENO
V. Personality and Health in Hunza Valley. Ed. by K. IMANISHI
VI. The Zirni Manuscript. Ed. by S. IWAMURA
VII. Geology of Karakoram and Hindukush. Ed. by S. MATSUSHITA
VIII. Additional Reports. Ed. by S. KITAMURA and R. YOSII

Volume I (pp. 361) contains the results of the investegations on cultivated plants and their relatives collected from Pakistan, Afghanistan and Iran including wheat, *Aegilops*, barley, various species of Gramineae and other crops. In the latter part, the photographs and the narrative of itineraries are also given.

III. Editorial Remarks

Explanation of the Figure on the cover

Diagram of showing the populations of rye with accessory chromosomes in Korea. Numerals indicate the locality Nos. Average number of the B-chromosomes per plant is represented by the black area in the circle, for instance:

○ : 0.00, ◔ : 0.50, ◑ : 1.00, ◕ : 1.50, ● : 2.00

(Small circle represents the population in which 11～30 plants were observed, and large circle represents the population in which 31～51 plants were observed.)

— Woong-Jik LEE and Byung-Re MIN, S. page 27 —

Announcement for further issues

WIS No. 22 will be ready for publication in March, 1966. Manuscripts for further 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*, *Agropyron*, *Secale*, *Haynaldia* and related genera. The manuscripts should not exceed 3 printed pages. List of stocks is exempted from this page limit.

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The Managing Editor

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