STUDIES ON THE CYTOLOGICAL INSTABILITIES OF COMMON WHEAT

I. The meiotic abnormalities of dwarf wheat, NÖRIN No. 10, with special reference to the appearance of tall plants.*

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I. Introduction

A variety of wheat, NÖRIN No. 10 is the long-awned dwarf wheat developed at the Nat. Agr. Exp. Sta. in 1924 by the artificial crossing between "Turkey Red" and "Fultz-Daruma" with the former variety as female. Owing to the data at that time when this variety was certificated and named, it is recorded the culm-length to be 52 cm., but recently in the foundation field of this variety to keep up its purity there appeared frequently the tall plants with culm-length of 90 cm. or so, sometimes over 100 cm.. Thus no line has been obtained bred true of dwarfishness in spite of the severe selection being continued every year. Consequently, its worth as the foundation seeds is coming to be questionable. Therefore, to find out the way to solution by pursuing this causes, the present author undertook the genetical and cytogenetical investigations on this material, and was able to know a part of the causes on the unfixabilities of this dwarf variety. This paper deals with the results of the cytogenetical studies obtained.

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II. Material and Methods

The foundation seeds of wheat, NÖRIN No. 10 were used in this experiment, which have been selected severely every year in our farm. The

tall plants which appeared in the field in 1952 were all collected and classified into two types by their culm-length,—the long-culm type over 80 cm. and the medium-culm type below 80 cm., and from each type one plant similar to the original in other characters except culm-length, namely, the plant with hairless and long-awned white glumes was chosen respectively (Fig. 1), from whose

Fig. 1.

selfed-seeds 20 plants (10 plants in each) were grown with 1 plant per pot. Besides, as the control 10 plants were prepared from the selfed-seeds of the original dwarf type. Thus 30 plants in total were placed in the cool glass-room during winter until next spring, when they were transplanted in the field after the root-tips of each plant were sampled and fixed. The cytological observations were carried out in both root-tips and PMCs of

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** 東北農業試験場盛岡試験地

these plants.

The root-tips pretreated by L.D.Cua's Method (immersed in water for 24 hours with 0°C.) were fixed by Farmer's fluid (3:1 acetic-alcohol) for the same hours, then the squashed-preparations were made according to the Warmke's Method. For PMCs, on the other hand, which were fixed by Farmer's fluid for 24 hours, Feulgen's squashed Method was mainly adopted, although Belling's iron-acetocarmine Method was used also.

All figures of chromosomes were drawn with the aid of Eruma drawing apparatus, and for taking the micro-photographs Olympus 35 was used.

Moreover, fertility was determined by the percentage of seeds setting in the first and second florets of each spikelet.

III. Results

A) The frequency of appearance of tall plants and their morphology.

Table 1 shows the frequency with which the tall plants appeared in the foundation field in 1952 and 1953. From this table it is to be seen that

Table 1. The frequency of appearance of tall plants

Year	No. of plants grown	No. of tall plants appeared	Frequency
1952	2064	76	3.68%
1953	1700	103	6.06%

there is a difference between years, namely, about 4% of tall plants were raised in 1952, while 6% in 1953. The morphology of tall plants is variable, especially so in the characters of spikes, for example, there appeared various types of tall plants combined with such characters as glume color (red or white), pubescent hairs on glumes (present or absent), awns (long, short or awnless), shape of spikes (lax, compact or square-head) and quality of grains (glassy or starchy) notwithstanding that the original form of variety, NÖRIN No. 10 has hairless and long-awned white glumes as already mentioned.

B) Karyological observations.

The somatic chromosome numbers in root-tip

Table 2. Chromosome numbers and morphology of respective 10 plants in the next generation of each type.

Type of Plant	Individual No.	2n	Culm Length	Classification of Plant Type	No. of Spikes	Length of Spikes	Length of Rachis	No. of Spikelets	Spike Density	Length of Awns	Fertility	Color of Glumes	Pube-scence	
Dwarf Plants	ave- rage of 10 plants	42	cm. 59.1	Dwarf	53	cm. 9.9	cm. 8.8	17.3	1.85	cm. 4.9	% 92.20	White	Absent	
Tall Plants	Medium-Culm Type	1	42	62.2	Dwarf	72	11.7	10.8	23.8	2.11	1.2	78.36	Yellow	Absent
		2	42	53.0	"	52	10.3	9.4	21.0	2.13	1.8	73.81	"	"
		3	42	57.2	"	78	10.7	9.8	20.2	1.96	2.6	77.97	"	"
		4	42	94.2	Long	74	10.9	10.0	20.4	1.94	1.8	79.90	"	"
		5	42	92.0	"	63	11.4	10.5	20.3	1.84	4.0	82.76	"	"
		6	42	90.0	"	75	10.6	9.6	18.3	1.80	4.2	83.04	"	"
		7	42	76.2	Medium	62	10.8	9.8	19.1	1.85	2.8	84.56	"	"
		8	43	78.6	"	77	11.4	10.3	19.1	1.76	4.1	57.33	White	"
		9	42	60.4	Dwarf	70	9.9	8.9	19.4	2.07	3.1	79.90	Yellow	"
		10*	—	—	—	—	—	—	—	—	—	—	—	—
	Long-Culm Type	1	42	111.0	Long	67	10.5	9.4	18.2	1.83	4.9	98.08	White	Absent
		2	43	55.6	Dwarf	33	12.2	11.0	22.9	1.99	3.8	65.31	Yellow	"
		3	43	77.0	Medium	93	10.0	8.8	17.0	1.82	3.0	77.78	White	"
		4	42	82.0	Long	80	11.4	10.4	22.4	2.06	4.5	83.93	Red	"
		5	42	82.5	"	62	9.6	8.6	17.5	1.92	4.5	85.71	Yellow	"
		6	42	75.0	Medium	38	10.1	9.1	19.4	2.02	4.4	80.93	"	"
		7	42	82.5	Long	42	9.6	8.5	16.5	1.82	5.0	90.91	"	"
		8	42	91.5	"	57	12.2	11.1	21.0	1.80	4.4	90.95	Red	"
		9	42	82.0	"	55	11.8	10.8	21.4	1.89	5.1	92.29	"	"
		10	42	50.3	Dwarf	44	8.5	7.7	18.4	2.26	2.4	39.95	"	"

* Died at seedling stage.

cells were determined of the 10 plants in the next generation of each type respectively. As shown in table 2, three trisomic plants in total were found, 1 in the offsprings of the medium-culm type, 2 of the long-culm type respectively (see also Fig. 2).

Fig. 2

But in the next generation of the dwarf type, none of tall plants appeared. Perhaps it will be due to the small number of plants examined. Therefore, from the tall plants which appeared in the foundation field this spring, 10 plants were picked up at random, and their somatic chromosome numbers were calculated by observing the chromosome configurations at MI in PMCs. Consequently, it was found there also existed 2 trisomics in addition to the usual hexaploid plants ($2n=42$) among them (table 3). In table 4, the chromosome configurations at MI in PMCs and their frequency were given of these plants which appeared in the next generation of each type together with one of two trisomics described above. In table 5, the types of chromosome associations were shown somewhat in detail.

Herewith, it is quite interesting to note that the variety, NÖRIN No. 10 itself showed some irregularities in meiosis, and accordingly there were observed without exceptions some PMCs having $20_{II}+2_I$ in addition to those with 21_{II} at MI. And yet, the PMCs with 4 to 6 univalents, rarely with 1 trivalent or 1 tetravalent were also met with (Fig. 3). Such irregularities as described above were also found in the plants with $2n=42$ which appeared in the next generation of the long-culm type and of the medium-culm type respectively. Therefore, it can be stated that there is no intrinsic difference cytogenetically between the long-culm type and the medium-culm type.

The percentage of irregularities which was calculated as the proportion of cells with the abnormal conjugations to the total number of cells observed was given at the last column in table 4, from which it was seen that the values ranged from ca. 4% to 31%, and there existed the tendency to be higher in the individuals which appeared in the next generation of tall plants than in that of dwarf types. The same relation is to be seen in trisomics ($2n=43$) also, the percentage of irregularities which was calculated by designating the conjugations except $21_{II}+1_I$ as the abnormal ones being higher in trisomics which appeared in the next generation of tall plants than in those of dwarf plants. Namely, the former showed from 43 to 62%, while the latter 35%. Next, researching the process of meiosis in dwarf plant which is original form of NÖRIN No. 10, the PMCs showing 2 unpaired chromosomes at diakinesis were often met with in addition to the normal plates with all chromosomes paired (Fig. 4). At MI, PMCs with 2 univalents, rarely 4 to 6, were frequently observed as already stated, and perhaps these PMCs with 2 univalents must have been derived from those showing 2 un-

Table 3. Chromosome numbers and morphology of 10 tall plants sampled out at random of foundation field.

Individual No.	$2n$	Culm Length	Length of Spikes	Length of Rachis	No. of Spikelets	Spike Density	No. of Spikes	Length of Awns	Color of Glumes	Pubes- cence	Shape of Spikes	Fertility
		cm.	cm.	cm.				cm.				%
DT-1	42	95.5	11.7	10.3	20.3	1.87	21	2.8	Red	Absent	Rod	96.72
-2	42	79.0	8.6	7.5	19.0	2.40	6	1.5	"	"	"	61.18
-3	42	85.5	10.6	9.2	18.9	1.95	11	2.2	"	"	"	92.11
-4	42	83.0	11.5	10.3	19.9	1.83	14	2.6	"	"	"	86.67
-5	42	90.7	10.3	9.0	19.6	2.07	17	1.8	"	"	Spear	80.00
-6	43	94.5	10.9	8.2	19.6	2.27	18	2.8	"	"	Rod	84.00
-7	42	92.5	8.4	7.3	16.7	2.15	7	5.4	White	"	"	81.00
-8	42	96.0	11.9	10.8	21.3	1.88	24	2.7	Red	"	"	91.70
-9	43	79.2	12.3	10.9	19.3	1.68	30	2.7	White	"	"	60.23
-10	42	95.0	11.0	9.9	19.6	1.87	22	2.6	Red	"	"	83.33

Table 4-A. Chromosome numbers, configurations and their frequency of plants in the next generation of each type.

Type of Plants	Individual No.	2n	Chromosome Configurations at MI								No. of PMCs observed	Percentage of Irregularities	
			21 _{II}	20 _{II} +2 _I	19 _{II} +4 _I	18 _{II} +6 _I	1 _{III} +18 _{II} +3 _I	1 _{III} +19 _{II} +1 _I	1 _{IV} +18 _{II} +2 _I	1 _{IV} +19 _{II}			
Dwarf Type	1	42	100	6	—	—	—	—	—	—	106	5.66%	
	2	42	85	4	—	—	—	—	—	—	89	4.49	
	3	42	69	27	2	—	—	1	—	1	100	31.00	
	4	42	120	10	1	—	—	—	—	—	131	8.40	
	5	42	86	13	1	—	—	—	—	—	100	12.24	
	6	42	90	12	3	1	—	—	—	—	106	15.09	
	7	42	120	7	—	1	—	—	—	—	128	6.25	
	8	42	120	11	1	—	—	—	—	—	132	9.09	
	9	42	98	8	1	—	—	—	—	—	107	8.41	
	10	42	120	13	2	—	—	—	—	—	135	11.11	
Tall Plants	Medium-Culm Type	1	42	80	29	2	—	—	1	—	—	112	28.57
		2	42	90	10	—	—	—	—	—	—	100	10.00
		3	42	100	9	—	—	—	—	—	—	109	8.26
		4	42	100	8	—	—	—	—	—	—	108	7.41
		5	42	100	12	3	—	—	—	—	—	115	13.04
		6	42	90	12	—	—	—	—	—	—	102	11.76
		7	42	100	5	—	—	—	—	—	—	105	4.76
		8	43	See table	4-B	—	—	—	—	—	—	—	—
		9	42	93	6	1	—	—	—	—	—	100	7.00
		10	—	—	—	—	—	—	—	—	—	—	—
	Long-Culm Type	1	42	75	18	3	2	—	—	1	1	100	25.00
		2	43	See table	4-B	—	—	—	—	—	—	—	—
		3	43	See table	4-B	—	—	—	—	—	—	—	—
		4	42	99	34	7	2	—	—	—	—	142	30.28
		5	42	80	15	4	2	—	—	—	—	101	20.79
		6	42	77	20	2	—	1	—	—	—	100	23.00
		7	42	87	11	2	—	—	—	—	—	100	13.00
		8	42	100	4	—	—	—	—	—	—	104	3.85
		9	42	85	17	1	—	—	—	—	—	103	17.48
		10	42	100	11	—	—	—	—	—	—	111	9.91

Table 4-B. Chromosome configurations and their frequency of trisomics which appeared in the next generation of each type.

Trisomics*	2n	Chromosome Configurations at MI									No. of PMCs Observed	Percentage of Irregularities
		21 _{II} +1 _I	1 _{III} +20 _{II}	20 _{II} +3 _I	19 _{II} +5 _I	1 _{III} +19 _{II} +2 _I	1 _{III} +18 _{II} +4 _I	1 _{III} +17 _{II} +6 _I	2 _{III} +17 _{II} +3 _I	1 _{IV} +19 _{II} +1 _I		
DT-6	43	65	18	7	—	10	—	—	—	—	100	35.00%
M-8	43	49	34	9	—	6	1	1	—	—	100	51.00
L-2	43	30	19	17	2	6	5	—	1	—	80	62.50
L-3	43	57	13	23	—	6	—	—	—	1	100	43.00

* DT denotes the tall plants sampled out at random of foundation field (See table 3). M and L denote the Medium-culm type and the Long-culm type respectively.

Table 5. Meiotic behaviours on some of the plants which appeared in the next generation of each type.

Plants*	Chromosome association Items examined	2n	I	II			III	IV	Total No. of Bivalents**	No. of PMCs observed
				open	closed	total				
D-3	Range	42	0-4	0-5	15-21	19-21	0-1	0-1	19-21	100
	Mode		0	1	19	21	0	0	21	
	Average		0.63	2.11	18.54	20.65	0.01	0.01	20.68	
M-9	Range	42	0-4	0-7	14-21	19-21	0	0	19-21	100
	Mode		0	2	19	21	0	0	21	
	Average		0.16	2.28	18.64	20.92	0	0	20.92	
L-1	Range	42	0-6	0-9	11-21	18-21	0	0-1	18-21	100
	Mode		0	2	18	21	0	0	21	
	Average		0.62	2.88	17.77	20.65	0	0.02	20.69	
DT-6	Range	43	0-3	0-7	13-21	19-21	0-1	0	20-21	100
	Mode		1	3	17	21	0	0	21	
	Average		1.06	2.88	17.67	20.55	0.28	0	20.65	
M-8	Range	43	0-6	0-8	12-21	17-21	0-1	0	18-21	100
	Mode		1	1	19	21	0	0	21	
	Average		0.96	2.27	18.12	20.39	0.42	0	20.80	
L-2	Range	43	0-5	1-11	8-20	17-21	0-2	0	19-21	80
	Mode		1	3	17	21	0	0	21	
	Average		1.58	3.95	16.19	20.11	0.40	0	20.51	
L-3	Range	43	0-3	1-9	12-20	19-21	0-1	0-1	20-21	100
	Mode		1	4	16	21	0	0	21	
	Average		1.39	4.23	16.27	20.50	0.19	0.01	20.71	

* D, M and L denote the Dwarf type, the Medium-culm type and the Long-culm type respectively. (See table 4-A).

DT denotes the plants sampled out at random of foundation field (See table 3).

** Reckoned a trivalent as one bivalent, a tetraivalent as two bivalents, respectively.

Fig 3

Fig. 4

paired chromosomes at diakinesis as described above, though no PMC showing 4 to 6 unpaired chromosomes was met with at diakinesis. In the most of PMCs showing 21_{II} at MI, 1-5 open bivalents were observed, of which at least one is

conjugated very loosely, and there were also some individuals which showed frequently the nonorientation of bivalents at MI (Fig. 4). Laggards and bridges were frequently observed both at first and second anaphase or telophase, though their frequency was somewhat higher in first division than in second. As a result of such irregularities there appeared some pollen tetrads with 1 or 2 micronuclei as shown in table 6. Moreover, there was to be seen such a plant as contained PMCs showing different stages in the same anther locule. Figure 5-2 shows the PMCs at diakinesis to be scattered among the monospores derived from pollen tetrads. The behaviour of chromosomes in meiosis of tall plants which appeared in the next generation of dwarf type was also just the same as that of the dwarf type itself described above, though there were a little wide variations in the frequency of laggards and bridges. Thus, among the plants with 42 somatic chromosomes there was not to be seen even one plant with no univalent at MI throughout every type.

The chromosome configurations and their frequency at MI of trisomics which appeared in the tall plants were given in table 4-B and in table 5.

Table 6. The comparison of the pollens and the seeds from trisomics with those from original dwarf plant

Plants	2n	No. of micronuclei in a monospore of pollen tetrad				Pollen Fertility	Seed Fertility	Size of Seeds		Weight of Seeds		Percent of Germination
		0	1	2	Total			Length	Width	Selfed Seeds	Opened Seeds	
D-3	42	1596	4	0	1600	95.06%	89.49%	6.09 mm.	3.17 mm.	32.01 mg.	38.73 mg.	86.67%
DT-6	43	1177	21	2	1200	69.31	84.00	6.07	3.27	45.21	51.14	96.67
M-8	43	1966	33	1	2000	93.92	57.33	6.01	2.74	28.29	33.07	96.67
L-2	43	700	82	10	792	54.44	65.31	6.11	3.14	33.86	43.51	100.00
L-3	43	701	83	4	788	92.06	77.78	6.19	2.85	27.41	35.17	100.00

1

2

3

4

5

Fig. 5

The chromosome configuration which was observed most frequently was $21_{II}+1_I$, followed by $1_{III}+20_{II}$, $20_{II}+3_I$ and $1_{III}+19_{II}+2_I$ in this order noted, and, very rarely, 2 trivalents or 1 tetravalent chromosomes being also met with (Fig. III and V). At AI of trisomics, the chromosome distribution of 21:22 was sometimes observed. Perhaps this indicates that an extra univalent in trisomics occasionally passes at random to alternative pole without splitting at 1-st division, and divides equatorially at 2-nd division. Chromosome bridges and laggards were observed frequently in both 1-st and 2-nd divisions. The characters of seeds in these trisomics were given in table 6. According to it, the different values were observed in different plants especially in the fertility of pollens and of seeds and in the weight of seeds.

IV. Discussion

A variety of wheat, NÖRIN No. 10 is the one derived from the intervarietal cross, which has been highly esteemed as the variety available for the inter-culture in vegetable-fields or orchards in Tōhoku districts, especially in both Iwate and Yamagata prefectures because of its short culm-length and winterhardiness.

The first cross was made in 1924 at NISHIGAHARA Nat. Agr. Exp. Sta., and the F_4 seeds were delivered in 1928 from KŌNOSU Exp. Farm, Nat. Agr. Exp. Sta. to Iwate Pref. Agr. Exp. Sta. as the materials to be used for the provincial tests of wheats which had been entrusted by the Ministry of Agriculture and Forestry. Since then selection was carried on them and in 1932 the name "TŌHOKU No. 34" was given to one of lines which bred true in regard to the characters desired.

Thus on October 1935, it was certificated and registered as the variety, "Wheat NÖRIN No. 10" and released to farmers. Of course, at that time when developed, this wheat has kept its purity as the dwarf variety, and no variation has been observed like today either in culm-length or in other characters. According to Mr. S. ŌTANI, it is from 1938 or so that there begin to appear the tall plants in the foundation field. However, these tall plants used to be removed for the first time whenever discovered, since they were misconceived as the contaminated plants derived from the seeds of other varieties fallen on the ground. Though afterwards it was noticed that these tall plants must have been derived from NÖRIN No. 10 itself as the variant, no one undertook the investigations to solve this problem.

After surveying the literatures on the mutations of common wheats (*Triticum vulgare* Vill.), the present author found out two cases similar to

NÖRIN No. 10, one, the unfixable dwarf wheats reported by de VILMORIN (1913), the other, speltoid wheats by NILSSON-EHLE (1917) and others. As to the former, which does not breed true in spite of the severe selection and always segregates some normal high plants with it, an extensive genetical investigation was carried out also by ENGLEADOW and WADHAM (1926), but they could not withdraw any definite conclusion from it, only suggesting that it seems to be due to the chromosomal aberrations. HUSKINS (1932), however, undertook the cytogenetical studies on the same material, and found that this VILMORIN's dwarf wheat segregates on selfing the normal plants having $2n=42$ (bred true), the dwarf plants having $2n=43$ (trisomics) and a few number of bushy plants having $2n=44$ (tetrasomics) usually, thus producing no dwarf wheat bred true. On the other hand, the latter, speltoid wheats, so designated on account of their spike shape being similar to that of *T. Spelta* L., frequently appear in the common wheats as the natural mutants, being classified 3 series, A, B and C, respectively. This mutants, since at first reported by NILSSON-EHLE in 1917, were researched by many workers, and it was elucidated by UCHIKAWA (1936, 1941) that A-series of speltoids are caused by a complex mutation of genes, B-series by the deficiency of a whole chromosome designated C, and C-series by the partial deficiency in C-chromosome.

Moreover, the speltoids studied so far were all that of foreign varieties, but ISHIKAWA (1934) reported the similar mutation in the varieties of our country, "SHIRO-KOMUGI No. 1" and "HAYAKOMUGI", which appeared in the certified fields of wheats, and according to him, it appeared also in "HATADA-KOMUGI" at Okayama Pref. Agr. Exp. Sta..

Now, the present author carried out the cytogenetical studies on this variety, NÖRIN No. 10 in question, and found out that it belonged neither to VILMORIN's dwarf wheat nor to speltoids but to wholly new category, judging from the behaviour of chromosomes in meiosis, the segregating ratio and the morphology of this wheat.

As it is clear from table 4-A, the dwarf wheat, NÖRIN No. 10 itself shows considerable irregularities in meiosis, and among tall plants derived from the original dwarf plant there are two different types, one showing irregularities in meiosis in spite of their having 42 somatic chromosome numbers like the dwarf plant, and the other having 43 somatic chromosomes instead of 42. Therefore, no plant has been obtained bred true up to date. As described above, the breeding behaviour of the original dwarf type is very irregular, and the PMCs

from 5 to 30 % of the total number of cells observed show $20_{II}+2_{I}$. Accordingly, among gametes produced, those having 20 or 22 chromosomes in addition to normal gametes having 21 must have been produced in considerably high frequency. Therefore, when these gametes having 20 or 22 chromosomes are united with the normal ones after fertilization, there come to arise naturally the zygotes having 43 somatic chromosomes which were demonstrated by the discovery of trisomics among the tall plants as shown in table 2 and 3. However, the present author has never met with not only the plants having 40 or 44 somatic chromosomes but also those having 41 chromosomes which may be expected as a matter of course. Regarding this point, he believes the reasons as follows:

As SEARS (1939) pointed out, the zygotes with whole-chromosome deficiencies and duplications are viable in such compound species as common wheat (allopolyploid). Therefore, only assuming that in the male side, the pollen grains with deficiencies and duplications fail to take part in the fertilization as a result of their being defeated at certation with the normal ones, while in the female side, the gametes with duplications do perhaps better function than those with deficiencies though they have only lower fertilizing ability than that of the normals, it is easily understood that trisomics will appear more frequently than monosomics, and nullisomics ($2n=40$) or tetrasomics ($2n=44$) are not formed in these plants on selfing. However, monosomics may be found out of a number of plants are examined.

Then, what is the reason that univalents do occur so frequently in meiosis of the dwarf type, NÖRIN No. 10?

As well known, the common wheat has 3 different genomes, A, B and D, and each genome is constituted of 7 pairs of chromosomes respectively, which have some partial homology with each other. And normally 21 bivalents are formed by autosyndesis at MI in meiosis, but in the case when allosyndesis takes place between the chromosomes of different genomes owing to the partial homology, the corresponding partners unpaired remains as univalents. Also the formation of multivalents can be likewise explained by assuming allosyndesis. Probably on a certain chromosome or chromosomes of this variety, the gene or genes to induce allosyndesis must have been carried as a result of mutation. And such mutation must have occurred spontaneously in wheat NÖRIN No. 10 soon after its development, and resulted in the appearance of tall plants, but these were misconceived as the plants mixed, having been removed whenever dis-

covered. Thus, only the progenies of the dwarf plants themselves which were instable cytologically must have been reproduced unconsciously up to date without being aware of the situations as described above. However, it is still difficult to explain the reasons by the available data why the tall plants having 42 somatic chromosomes do appear from the dwarf plants, and further studies have to be carried out to make clear this point.

Whatever the cause may be that induced such mutation, there must be surely some offsprings of those which did not mutate as long as it is one of the crops in which mass production has been continued. Accordingly, it is expected to be able to obtain the original pure line by applying pedigree culture upon them.

V. Summary

1) In the dwarf wheat, NÖRIN No. 10, the tall plants appear in frequency from 4 to 6 per cent, among which a few number of trisomics are included.

2) This cause is ascribed to the abnormalities in meiosis of the original dwarf type itself, at MI of which 2 univalents, rarely from 4 to 6, are observed, occasionally 1 trivalent or 1 tetravalent chromosome also being met with.

3) The behaviour of chromosomes in meiosis of the tall plants having 42 somatic chromosomes is also just the same as in the dwarf type, and on selfing some trisomics segregate again in the next generation together with the instable plants having 42 chromosomes and never breed true.

4) The modal chromosome configuration at MI of trisomics is $21_{II}+1_{I}$, followed by $1_{III}+20_{I}$, $20_{II}+3_{I}$ and $1_{III}+19_{II}+2_{I}$ in this order noted, and an extra univalent in trisomics sometimes passes to the alternative pole at random without splitting at first division.

5) In the fertility of seeds there is no difference between the dwarf and the tall types having 42 somatic chromosomes, but in trisomics different values are observed in different plants especially in the fertility of both pollens and seeds, and in the weight of seeds.

6) It was inferred that the cause of appearance of univalents at MI of dwarf types was due to allosyndesis induced by the partial homology between different genomes, and the gene or genes to induce allosyndesis must have occurred by mutation.

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Explanation of Figures

Fig. 1. Three different types of wheat, NÖRIN No. 10, from whose selfed-seeds the present material was prepared.

left: Long-culm type
center: Medium-culm type
right: Original dwarf type

Fig. 2. Somatic metaphase plates

- 1: original dwarf type ($2n=42$)
- 2: trisomics which appeared in the tall plants ($2n=43$)

Fig. 3. First metaphase plate in the dwarf type and the trisomics

1-5: dwarf type ($2n=42$) 6-10: trisomics ($2n=43$)

1: 21_{II}	5: $1_{IV}+19_{II}$
2: $20_{II}+2_I$	6: $21_{II}+1_I$
3: $19_{II}+4_I$	7: $1_{III}+20_{II}$
4: $1_{III}+19_{II}+1_I$	8: $20_{II}+3_I$
9: $1_{III}+18_{II}+4_I$	10: $1_{IV}+19_{II}+1_I$

Fig. 4. Meiosis in the dwarf type and the trisomics

- 1-5: Diakinesis
- 1: diakinesis showing 2 unpaired chromosomes (dwarf type)
- 2: Diakinesis observed with PMCs of tetrad stage in the same anther locule, (dwarf type)
- 3: normal diakinesis (dwarf type)
- 4: diakinesis showing 3 unpaired chromosomes (trisomics)
- 5: diakinesis showing 1 unpaired chromosomes (trisomics)
- 6: Non-orientation of closed bivalent (dwarf type)
- 7: Non-orientation of open bivalent (dwarf type)
- 8: Chromosome bridge (dwarf type)
- 9: Two dividing univalents lagging at first anaphase (dwarf type)
- 10: Chromosome distribution of 21:22 at first anaphase (trisomics)
- 11: Interkinesis (dwarf type)
- 12: Second anaphase showing lagging chromosomes (dwarf type)
- 13: Pollen tetrad with micronuclei (dwarf type)
- 14: Pollen tetrad with an extra cell (dwarf type)

Fig. 5. Microphotographs of diakinesis and first metaphase

- 1: Microphotograph of the same plate and Fig. 4-1.
- 2: Microphotograph of the same plate as Fig. 4-2.
- 3: Microphotograph of the same plate as Fig. 4-3.
- 4: Microphotograph of the same plate as Fig. 4-5.
- 5: Microphotograph of the same plate as Fig. 4-10.

普通小麦の細胞学的不安定性に関する研究

第1報 矮性小麦農林 10 号の成熟分裂異常特に高性型の出現について

渡 辺 好 郎

(摘 要)

小麦農林 10 号は「ターキーレッド」×「フルツダルマ」の人工交配によつて作られた矮性長芒品種で、命名当時の成績によると稈長 52 cm と記載されているが、純粋保存を図っている原々種圃に近年かなりの高頻度で 90 cm 内外稀に 100 cm を超える個体が出現し、いかに淘汰しつづけても矮性に固定した系統が得られず原々種としての価値を疑わしめるに至っている。その原因を追求した結果本品種の非固定性の原因の一部が成熟分裂の異常に基づくことを知った。

即ち、農林 10 号の原々種圃に出現した長稈型 (80 cm 以上)、中稈型 (80 cm 以下) 並びに本来の標準短稈型 (矮性型) 各 1 個体の自殖種子より次代植物をそれぞれ 10 個体ずつ養成し、それら 30 個体の根端染色体数並びに花粉母細胞成熟分裂第一分裂中期の染色体の行動を調査したところ、第 2 表に示す如く中稈型次代に 1 個体、長稈型次代に 2 個体、計 3 個体の trisomics ($2n=43$) の出現を見た。個体数が少かつたため矮性型次代に高性型の出現を見なかつたが、この年原々種圃に現われた高性型個体中より 10 個体を任意に採取して染色体数

を調査した結果、第3表の如くこの中にも2個体の trisomics が含まれていた。仍つて本来の矮性型自体の成熟分裂を調べたところ、染色体数はいずれも $2n=42$ で異常はなかつたが、このものの染色体の行動が極めて不規則で、第4表に示すごとく MI で 21_{II} を有する PMC の他に $20_{II}+2_I$ を示す PMC が例外なしに観察され、個体によつては4~6個の一価染色体、稀に1個の三染色体或は四価染色体が見られた。同様な異常は中稈型、長稈型(以下単に高性型と総称)の次代に現われた $2n=42$ の植物或は矮性型次代に現われた $2n=42$ の高性個体にも観察され、細胞学的には中稈型と長稈型とを区別する必要はない。高性型の出現頻度も年により変動し、1952年には4% 1953年には6%の出現率を示した(第1表)。

trisomics の染色体接合型は大部分 $21_{II}+1_I$ で、 $1_{III}+20_{II}$ 、 $20_{II}+3_I$ 及び $1_{III}+19_{II}+2_I$ の順でこれに次ぎ、極く稀に2個の三価或は1個の四価染色体が見られた。

花粉稔性及び種子稔性は $2n=42$ の個体にあつては矮性型も高性型も大差がなかつたが、trisomics では個体によつて著しい変異を示した。

以上の如く矮性型自体の成熟分裂の乱れから $2n=43$ の trisomics が生ずるわけであるが、当然期待されてよい $2n=41$ の個体に未だ遭遇していない。この理由について若干論じ、調査個体数を増すことによつて発見し得べきことを予想した。

では何故、標準矮性型自体の PMC に2個、稀に4~6個もの一価染色体が生ずるのか。その理由として著者は小麦を構成する3つの異なつたゲノム、A、B及びD間の部分相同性による異親接合(allosyndesis)の結果と推論し、かかる異親接合を生ぜしめる因子が突然変異によつて生じたものであらうと考えている。然し乍らいかなる機構によつて $2n=42$ の高性型が析出するものかについては現在の所尙不明で今後の研究に俟たねばならない。

アラスカ豌豆の化学物質による花芽分化促進作用

LEOPOLD, A. C. and F. S. GUERNSEY : Flower initiation in the Alaska pea.

II. Chemical vernalization. Amer. Jour. Bot. 41 (3) 1954.

著者等はアラスカ豌豆で種子をオーキシン処理して後低温処理すると花芽分化促進作用のある事を見たが(本誌前号抄録参照)更に引続き同様処理を日長及び低温処理効果の異なる種々の作物(大麦・テオシント・大豆・燕麦・玉蜀黍等)に施して同様に促進作用のある事を見た(LEOPOLD, A. C. and F. S. GUERNSEY : Amer. Jour. Bot. 40 (8))。

本実験ではナフタレン醋酸以外の化学物質の効果を検定し更に処理条件又は其の後の環境条件の相違が花芽分化促進効果に及ぼす影響を検討して化学物質による花芽分化促進作用(この作用を chemical vernalization と呼んでいる)の本質を推論している。

実験材料はアラスカ豌豆を用いた。実験の結果オーキシンで促進作用の認められたものはナフタレン醋酸、インドール醋酸、インドール酪酸、 β -naphthoxyacetic acid、*p*-chlorophenoxyacetic acid 等でオーキシン以外で効果のあつたものは TIBA 及びチアミンであつた。

次に処理の方法及び環境条件の相異が促進効果に及ぼす影響を知るため次の6つの実験を行つた。(1)光の強さを一定にし日長時間(0~18時間)とオーキシン濃度(0.01~0.1 P.P.M.)を変化させた場合、オーキシン処理後 18°C に保つた区は何れも分化が抑制された。 3°C の低温区は何れの日長時間でも促進効果が表われ、特に濃度 0.01 P.P.M. では第一花着生節

位で2節の低下が見られた。(2)日長時間を一定(18時間)にし光の強さを(40~800 ft.c.)変化した場合 18°C 区では抑制され 3°C では 40~400 ft.c. 間では促進されるが其れ以上の強光下では促進効果は急減した。(3)オーキシン低温処理後高温にさらした場合、 39°C に種々の時間さらした結果6時間で顕著に促進作用が軽減され 18~24 時間で完全に打消された。(4)窒素ガスにさらす事が低温処理効果を打消す働きのあることが報告されているがオーキシン低温処理後一定時間窒素ガス中に入れて其の影響をしらべた結果、2~4日間窒素ガス中に入れる事は促進効果を完全に抹殺するのに充分であつた。然し窒素ガスの作用は高温による作用よりずつと徐々に行われた。(5)オーキシン低温処理した後炭酸ガスを完全に除いた空気中に置いた結果、僅か1時間で促進作用は強く障害を受け 18 時間以上では効果は全く打消された。(6)低温処理期間中の炭酸ガス濃度を 0.001~40%迄変化させた結果、0~1%では影響なく 10% 以上では標準区も同様の障害を受けた。以上の実験結果から著者等は次の様な推論を試みている。化学物質による花芽分化促進作用には2つの段階がある。第一の段階は低温及びオーキシン又はオーキシンの効果を増加する物質の存在を必要とし、第二の段階は低温処理の終つた後に起り炭酸ガスの存在を必要とする或種の合成作用と考えられる。(東大農 佐俣淑彦)