Detection and Identification of Chromosomal Translocations in Japanese Common Wheat Varieties

Abdelbagi Mukhtar ALI, Noboru NAKATA, Motonori TOMITA and Yoshimasa YASUMURO

Faculty of Agriculture, Tottori University, Tottori, 680

Chromosome structures of six Japanese common wheat varieties, covering Japanese wheat genealogical table, were compared with that of the standard variety Chinese Spring (CS) and from each other. The meiotic configurations at the first metaphase of pollen mother cells were observed in twenty-one intervarietal hybrids. As many as five out of the six varieties contained one or two reciprocal translocations relative to CS. Shinchuunaga had no chromosomal translocations relative to CS. Norin 29, Igachikugo Oregon and Shirodaruma each had one reciprocal translocation relative to CS. These translocations were independent on each other. The translocation in Shirodaruma was between the B genome chromosomes, but the translocations in the other two varieties were between A and/or D genome chromosomes. Eshimashinriki and Saitama 27 each had two sets of independent reciprocal translocations. The translocation of Igachikugo Oregon involved the same chromosomes as one of the two translocations observed in Saitama 27 did. Also the translocation of Shirodaruma did the same ones as one of the two translocations of Eshimashinriki. A total of seven reciprocal translocations involving nine different chromosomes of the complement was observed. Half of the translocated segments were estimated to be of the B genome by using C-banding. These results indicate that many Japanese common wheat varieties should contain the various translocations with unexpectedly high frequency and be grouped into at least six types due to translocation.

KEY WORDS: *Triticum aestivum*, common wheat, chromosomal translocation, C-banding.

Introduction

Common wheat (*Triticum aestivum* L., $2n=6x=42$, Genome formula AABBDD) is allohexaploid having three genomes, which were derived from the genome of the common ancestral diploid species. In spite of partial homology among genomes, common wheat shows diploid-like meiotic behavior by the action of *Ph* gene on the long arm of chromosome 5B (OKAMOTO 1957, SEARS and OKAMOTO 1958, RILEY and CHAPMAN 1958, RILEY 1960).

Occasional occurrence of aneuploids due to meiotic instability in the course of wheat breeding was reported. This was mostly caused by the difference in chromosomal structures existing between parental lines (WATANABE 1962a, WORLAND and LAW 1985). Therefore, information on chromosomal translocations in common wheat varieties is useful in wheat breeding. Moreover, as many DNA markers are now developing in wheat and its relatives (APPELS *et al.* 1980, CHAO *et al.* 1989, LIU *et al.* 1990), this information can be utilized also in molecular mapping.

In European and American common wheat varieties, many translocations had been detected and identified (SEARS 1954, BAKER and MCINTOSH 1966, LARSEN 1973, METTIN and KLEIN

Received January 14, 1992.

Accepted June 5, 1992.

¹⁾ The new chromosome names of 4A and 4B to the former 4B and 4A, respectively (after KIMBER and TSUNEWAKI (1988) are used in this paper.

1973, BAIER *et al.* 1974, VEGA and LACADENA 1982). However, in Japanese common wheat varieties yet there is not so many reports on this area (SASAKI 1952, WATANABE 1962b, MAKINO and SASAKI 1970). The purpose of this study is to detect and compare chromosomal translocations among Japanese major varieties used in the cross-breeding, and to discuss the distribution of translocations in Japanese modern wheat varieties.

Materials and Methods

Six Japanese common wheat varieties, Shinchuunaga, Norin 29, Igachikugo Oregon, Shirodaruma, Eshimashinriki and Saitama 27 were investigated in this study. These varieties were chosen so as to cover Japanese wheat genealogical table (FUKUNAGA and INAGAKI 1985). Chinese Spring (denoted by CS) was used as the standard variety in this study. These varieties, except Saitama 27, are known to be used extensively in the development of Japanese commercial varieties. In southern Europe, varieties carrying the *Rht1S* dwarfing gene from Saitama 27 seem to have a selective advantage (WORLAND and PETROVIC 1988).

Twenty-one hybrids were obtained by the crosses among the seven varieties including CS. The hybrids were grown in a growth chamber after vernalization. Spikes of plants grown at 20°C and 24 hours day length were collected at appropriate stage and fixed in Carnoy's solution.

Preparation for observation of meiotic configurations was made by acetocarmine squash method. A minimum of 30 cells at the first metaphase (MI) of pollen mother cell (PMC) was examined in each combination.

The genomes of chromosomes involved in translocations were estimated by C-banding technique (NAKATA *et al.* 1977).

Results

Table 1. shows mean chromosomes pairing at MI in hybrids between CS and the six varieties. Fig. 1 shows the representative meiotic configurations by acetocarmine staining (a, b and c) and C-banding (d, e and f). The chromosomes of the B genome had prominent bands near the centromere by C-banding and were easily distinguishable from those of other genomes.

Shinchuunaga showed no multivalent in its hybrid with CS, where cells with 21 ring bivalents were observed (Table 1). This indicates close similarity of their chromosome structures.

Each of three varieties, Norin 29, Igachikugo Oregon and Shirodaruma, contains one reciprocal translocation because their hybrids with CS showed one quadrivalent (Fig. 1a). The frequency of multivalents in the hybrid between Norin 29 and CS was 6.7% which is lower than those in the other two kinds of hybrids (Table 1). This indicates that the translocation segments in Norin 29 are smaller than those of the other two varieties. The translocations in Norin 29 and Igachikugo Oregon were estimated to be between chromosomes of the A and/or D genome(s) by C-banding. On the other hand, the one in Shirodaruma was confirmed to be between chromosomes of the B genome.

Eshimashinriki had two independent reciprocal translocations in comparison to CS (Fig. 1b).

Only one out of 30 cells had shown a quadrivalent and a trivalent. The low frequency of cells having two multivalents may indicate that one of two translocations is smaller than the other. The two translocations were not distinguishable from each other by C-banding because all quadrivalents had shown prominent centromeric bands of the B genome. Moreover, in cells with one quadrivalent, rod bivalents among which the second translocation supposed to exist, frequently showed banding pattern of the B genome chromosomes (Fig. 1d). Therefore, both of these translocations probably involved chromosomes of the B genome.

In the hybrid between Saitama 27 and CS one quadrivalent or trivalent was observed in

Table 1. Pairing configurations at MI of the PMCs of the parental varieties and their F₁ hybrids with Chinese Spring (CS)

Variety X CS and parents	No. of PMCs observed	Average chromosome pairing per cell						Maximum multivalents observed per cell
		I	II		III	IV	Chiasmata	
			Rod	Ring				
Variety X CS:								
Shinchuunaga	30	0.33 (0~2) ¹⁾	1.97 (0~4)	18.87 (16~21)			39.70 (36~42)	0
Norin 29	30	1.13 (0~8)	3.87 (1~8)	16.43 (12~19)		0.07 (0~1)	36.93 (29~40)	1
Igachikugo Oregon	30	1.27 (0~8)	2.10 (0~5)	17.37 (13~19)	0.20 (0~1)	0.30 (0~1)	38.07 (33~41)	1
Shiroadaruma	30	1.37 (0~6)	3.77 (1~7)	15.37 (12~18)	0.30 (0~1)	0.37 (0~1)	36.20 (32~39)	1
Eshimashinriki	30	1.37 (0~4)	3.27 (1~9)	15.70 (12~18)	0.50 (0~1)	0.30 (0~2)	36.53 (32~40)	2
Saitama 27	34	1.10 (0~6)	4.27 (2~11)	14.83 (8~18)	0.10 (0~1)	0.60 (0~1)	36.23 (29~41)	1 ²⁾
Parents:								
CS	30	0.27 (0~2)	0.97 (0~3)	19.90 (17~21)			40.80 (37~42)	
Shinchuunaga	30	0.26 (0~2)	0.48 (0~2)	20.39 (18~21)			41.25 (38~42)	
Norin 29	30	1.40 (0~4)	2.97 (0~9)	17.33 (10~21)			37.63 (29~42)	
Igachikugo Oregon	30	0.13 (0~2)	1.23 (0~3)	19.70 (18~21)			40.63 (39~42)	
Shiroadaruma	30	0.13 (0~2)	1.67 (0~4)	19.27 (16~21)			40.20 (37~42)	
Eshimashinriki	30	0.20 (0~2)	2.35 (0~6)	18.55 (15~21)			39.48 (36~42)	
Saitama 27	30	0.13 (0~2)	1.50 (0~4)	19.43 (17~21)			40.33 (38~42)	

¹⁾: The range of the observed number.

²⁾: Two kinds of quadrivalent were observed in C-banding preparation.

70% of the examined cells (Table 1). However, multivalents were classified into two types by C-banding. One of them was involved with one chromosome of the B genome and the other did not. This suggests that Saitama 27 has two different reciprocal translocations relative to CS, one of which should be of small segments interchange, although cells with the two quadrivalents were not observed in the examined plates (Fig. 1f). This suggestion was also supported by the observation of one quadrivalent, and hexavalent or three quadrivalents in the hybrids of Saitama 27 with Igachikugo Oregon and Eshimashinriki, respectively.

For intervarietal comparison of the observed translocations, Table 2 demonstrates the critical

Fig. 1. Representative meiotic configuration at the first metaphase of pollen mother cell. Plates a, b and c were stained by Acetocarmine and plates d, e and f by C-banding. a: Igachikugo Oregon $\times$ Chinese spring (CS) showing 19II + 1IV, b: Eshimashinriki $\times$ CS showing 17II + 1IV + 1III + 1I, c: Shirodaruma $\times$ Igachikugo Oregon showing 17II + 2IV, d: Eshimashinriki $\times$ CS having quadrivalent and two out of three rod bivalents involving the B genome chromosomes, and e: Igachikugo Oregon $\times$ CS and f: Saitama 27 $\times$ CS each having quadrivalent involving the A and/or D genome chromosomes.

meiotic configurations in the hybrids among varieties and their frequencies in percentages. Shinchuunaga gave the same results as those of CS in its combinations with the other varieties. This confirms the close chromosomal constitution of Shinchuunaga and CS as observed in the hybrid between them.

The reciprocal translocation of Norin 29 relative to CS differs from those present in the other varieties, because its quadrivalent was observed in its hybrids with all of the other varieties. Although cells having two quadrivalents were observed in the hybrids of Norin 29 with Eshimashinriki and Saitama 27, quadrivalents were classified into three types by C-banding.

The reciprocal translocation of Igachikugo Oregon relative to CS involved the same chromosomes as one of the two observed in Saitama 27 did, because only one quadrivalent was observed in the hybrid between Igachikugo Oregon and Saitama 27. Moreover, the reciprocal translocation of Shirodaruma relative to CS was found to involve the same chromosomes as one of the two observed in Eshimashinriki.

The hybrid between Igachikugo Oregon and Shirodaruma showed two quadrivalents (Fig. 1c) indicating that the translocation observed in each variety relative to CS (shown early in Table 1) was on different chromosomes.

The hybrid between Eshimashinriki and Saitama 27 gave a maximum of three quadrivalents in one cell out of 30 cells and a hexavalent in four cells. The occurrence of hexavalent suggests that one of the two translocations observed in each variety relative to CS involved in a common chromosome, that is, the same segment in one chromosome was reciprocally translocated into different chromosomes in the two varieties, or one arm involved in translocation in one variety and the opposite arm of the same chromosome involved in different translocation in the other variety.

Table 2. Frequency (%) of multivalents observed in the F₁ hybrids between varieties

Variety	Norin 29	Igachikugo Oregon	Shirodaruma	Eshimashinriki	Saitama 27
	1IV	1IV	1IV	2IV, 1IV	1IV ¹⁾
Chinese Spring	6.7 (30)	50.0 (30)	66.7 (30)	3.3, 73.3 (30)	70.0 (34)
Shinchuunaga	6.7 (30)	10.0 (30)	70.0 (30)	3.3, 76.7 (30)	63.3 (30)
Norin 29		2IV, 1IV 3.2, 58.1 (31)	2IV, 1IV 13.3, 66.7 (30)	2IV, 1IV ²⁾ 12.1, 95.7 (33)	2IV, 1IV ²⁾ 3.3, 46.7 (30)
Igachikugo Oregon			2IV, 1IV 6.7, 77.7 (30)	2IV, 1IV ²⁾ 12.1, 72.7 (33)	1IV 26.7
Shirodaruma				1IV 13.3 (30)	2IV, 1IV ²⁾ 40.0, 50.0 (30)
Eshimashinriki					3IV, 2IV, 1VI 3.3, 30.0, 13.3 (30)

¹⁾ and ²⁾: Two and three kinds of quadrivalent were observed in C-banding preparation, respectively.

(): Number of cells observed.

Discussion

Five out of six Japanese varieties of common wheat used in this study contain one or two reciprocal translocations relative to CS. The frequency of translocations is high beyond our expectation. This indicates that translocations are probably present with high frequency in Japanese commercial varieties derived from these material varieties.

Shinchuunaga has more or less the same chromosomal constitution as that of CS. Norin 29, Shirodaruma and Igachikugo Oregon each had one reciprocal translocation. These three translocations were different from each other. Shirodaruma had the same chromosomal structure as that of Japanese variety Yuushouki (YASUMURO unpublished). On the other hand, Eshimashinriki and Saitama 27 each had two sets of reciprocal translocations, where a common chromosome involved in different translocations in both of varieties. One translocation of Eshimashinriki involved the same chromosomes as that of Shirodaruma, and one translocation of Saitama 27 did the same chromosomes as that of Igachikugo Oregon. After the genealogical table (FUKUNAGA and INAGAKI 1985), the varieties found to have the same translocation in this study have no relation in their pedigrees. This suggests that these varieties should have relation in the ancient time, or the same translocations occurred independently by the establishment of each variety. As WATANABE (1962a) reported that Saitama 27 had almost the same chromosomal structure as those of Nanbu komugi and Aoba komugi, the two varieties should have two translocations relative to CS.

On the base of above-mentioned result so far, Japanese common wheat varieties can be at least grouped into six types by chromosomal structure: (1) CS and Shinchuunaga, (2) Norin 29, (3) Shirodaruma and Yuushouki, (4) Igachikugo Oregon, (5) Eshimashinriki, and (6) Saitama 27, Nanbu komugi and Aoba komugi.

Three major sources of translocations were considered in Japanese common wheat. First, translocations occurred and maintained from ancient time in Japanese landrace varieties. Second, translocations introduced with European and American varieties which were used in Japanese wheat breeding. The third source is the genetic mutation in genes controlling meiosis in wheat which may lead to meiotic instability and misdivisions that result in chromosomal translocations (WATANABE 1962a).

The reciprocal translocation detected in the landrace Shirodaruma relative to CS might be occurred at ancient time (assuming CS has the original chromosomal structure (SEARS 1954)). This translocation should have been maintained for its breeding interest. Cultivars having this local variety in their pedigrees are expected to receive the translocation.

Many American and European varieties were used for Japanese wheat breeding. For instance, Norin 29 and Saitama 27 have the Russian variety Beloturka and the American variety California in their pedigrees, respectively. Igachikugo Oregon was derived from the hybrid between the landrace Igachikugo and the American variety Oregon. The translocations detected in Norin 29, Saitama 27 and Igachikugo Oregon might be derived from American and European varieties. Particularly the translocation in Igachikugo Oregon most possibly came from Oregon, because it was confirmed not to be received from Igachikugo by our recent observations. That is, the hybrid between Igachikugo and CS had shown one quad-

rivalent, however, two quadrivalents were observed in the hybrid between Igachikugo and Igachikugo Oregon. This indicates that although each of the two varieties had shown one quadrivalent with CS, these quadrivalents involved different chromosomes of the complement and obviously confirm that the translocation detected in Igachikugo Oregon did not come from Igachikugo.

It is known that chromosomal translocation takes place spontaneously in wheat and is occasionally transmitted in progeny because translocation does not severely reduce the fertility of hexaploid wheat (SEARS 1954, BAKER and McINTOSH 1966, BAIER *et al.* 1974). WATANABE (1962a) reported that translocations happened in the course of the development of the wheat line Kinai 15-b which showed meiotic instability. Spontaneous translocation between homoeologous chromosomes is known in the hybrid between wheat and its relatives (METTIN *et al.* 1973, MILLER *et al.* 1988). The wheat-alien translocations were mainly selected for disease resistance (ZELLER 1973).

In this study, a total of seven reciprocal translocations involving nine different chromosomes of the complement was detected in five varieties. Half of the translocated segments were presumed to be of the B genome. The overall summarization of the observed translocations is illustrated in Fig. 2. It shows the nine chromosomes of the complement involved in translocations and the presumed genomic group of each translocation.

Fig. 2. Chromosomal translocations detected in the six Japanese common wheat varieties relative to Chinese Spring. As the sites of the translocations are not known, they were drawn tentatively on the long arms. 1~9: Chromosomes involved in translocations (1~4: Chromosomes of the B genome and 5~9: chromosomes of the A and/or D genome(s) presumed by C-banding). (a): Chinese Spring and Shinchuunaga, (b): Norin 29, (c): Igachikugo Oregon, (d): Shirodaruma, (e): Eshimashinriki and (f): Saitama 27.

Twenty kinds of reciprocal translocations in common wheat had already been identified (MAKINO and SASAKI 1970, LARSEN 1973). Out of them six translocations were between chromosomes of the B¹ genome and ten translocations involved in one chromosome of the B genome. LARSEN (1973) suggested that the chromosomes of the B genome had more ability to perform chromosome rearrangement than those of other two genomes. The result in this study also indicates the variability of chromosomal structure of the B genome in wheat.

GILL and KIMBER (1977) identified the break points of 4B/6B translocated chromosomes in Thatcher by C-banding and JEWELL (1978) did those of 5B/7B in Poso by N-banding. However, the break points of the translocations detected in this study could not be identified by comparison of karyotypes by C-banding to the standard pattern of CS. This was due to the existing difference in the banding pattern of Japanese varieties relative to CS (ENDO 1986, MA *et al.* 1990). In addition translocations may involve non-banded segments.

Detection of translocations in Japanese commercial wheat varieties is going on by the same procedures used in this study. Out of the screened varieties Takune komugi and Haruminori had shown quadrivalents with CS. Takune komugi has Shirodaruma and Igachikugo Oregon in its pedigree, while Haruminori has Shirodaruma and Norin 29. If the translocations found in these two varieties were the same as those of the varieties in their pedigrees, the translocated chromosomes should be maintained and transferred during the development of these varieties due to their breeding potential and interest.

In conclusion, translocated segments carrying useful genes block will be favored in breeding and maintained in the developed cultivars. Japanese common wheat varieties should contain the various translocations detected here, because the varieties having translocations in this study were extensively used in Japanese wheat breeding. If parental varieties have different chromosomal structures due to translocation in intervarietal cross-breeding, chromosomal structural heterozygosity might result in meiotic irregularity and the occurrence of aneuploids even in the advanced generations (SASAKI 1952, WATANABE 1962b, WORLAND and LAW 1985). Thus, translocations will display various influences in the course of breeding in Japanese common wheat. On the other hand, translocations disturb location of genes and DNA markers to specific chromosome. DNA markers of wheat have been developed and located on critical chromosomes using CS and its aneuploids, nullisomic-tetrasomic and ditelocentric lines (CHAO *et al.* 1989, LUI and TSUNEWAKI 1991). Since DNA markers can be applied to identification of quantitative trait loci (OSBORN *et al.* 1987) and estimation of proportion of recurrent genome in backcross breeding (YOUNG and TANKSLEY 1989), the information of translocations will be useful for the application of DNA markers in the breeding of Japanese common wheat.

Literature Cited

- APPELS, R., W. L. GERLACH, E. S. DENNIS, H. SWIFT and W. J. PEACOCK 1980. Molecular and chromosomal organization of DNA sequences coding for the ribosomal RNAs in cereals. *Chromosoma* (Berl.) **78**: 293~311.
- BAIER, A. C., F. J. ZELLER and E. FISCHBECK 1974. Identification of three chromosomal interchanges in common wheat, *Triticum aestivum* L. *Can. J. Genet. Cytol.* **16**: 349~354.

- BAKER, E. P., A. R. MCINTOSH 1966. Chromosome translocations identified in varieties of common wheat. *Can. J. Genet. Cytol.* **8**: 592~599.
- CHAO, S., P. J. SHARP, A. J. WORLAND, E. J. WARNAM, R. M. D. KOEBNER and M. D. GALE 1989. RFLP-based genetic maps of wheat homoeologous group 7 chromosomes. *Theor. Appl. Genet.* **78**: 495~504.
- ENDO, T. R. 1986. Complete identification of common wheat chromosomes by means of the C-banding. *Jpn. J. Genet.* **61**: 89~93.
- FUKUNAGA, K. and M. INAGAKI 1985. Genealogical pedigree of Japanese wheat cultivars. *Japan. J. Breed.* **35**: 89~92.
- GILL, B. S. and G. KIMBER 1977. Recognition of translocations and alien chromosome transfers in wheat by Giemsa C-banding technique. *Crop. Sci.* **17**: 264~266.
- JEWELL, D. C. 1978. Recognition of alien material and chromosome rearrangements in wheat using N-banding. *Proc. 5th Intern. Wheat Genet. Symp.* 1208~1212.
- KIMBER, G. and K. TSUNEWAKI 1988. Genomic symbols and plasma types in the wheat group. *Proc. 7th Intern. Wheat Genet. Symp.* 1209~1211.
- LARSEN, J. 1973. The role of chromosomal interchanges in the evolution of hexaploid wheat *Triticum aestivum* L. *Proc. 4th Intern. Wheat Genet. Symp.* 87~93.
- LIU, Y. G. and K. TSUNEWAKI 1991. Restriction fragment length polymorphism (RFLP) analysis in wheat. II. Linkage maps of the RFLP sites in common wheat. *Jpn. J. Genet.* **66**: 617~633.
- , N. MORI and K. TSUNEWAKI 1990. ———. I. Genomic DNA library construction and RFLP analysis in common wheat. *Jpn. J. Genet.* **65**: 367~380.
- MA, Y. Z., N. NAKATA, M. TOMITA and Y. YASUMURO 1990. Karyotype variation in Japanese and Chinese common wheat. *Bull. Fac. Agric., Tottori Univ.* **43**: 1~7.
- MAKINO, T. and M. SASAKI 1970. Morphology and meiotic behaviour of univalent chromosomes of homoeologous group 5 from ten Japanese cultivars in wheat. *Seiken Zihō* **22**: 25~31.
- METTIN, D. and V. KLEIN 1973. Meiotic pairing behaviour and interchanges in intervarietal hybrids of common wheat. *Ewac News Letter* **4**: 30~34.
- , W. D. BLUTHNER and G. SCHLEGEL 1973. Additional evidence on spontaneous 1B/1R wheat-rye substitutions and translocations. *Proc. 4th Intern. Wheat Genet. Symp.* 179~184.
- MILLER, T. E., S. M. READER and D. SINGH 1988. Spontaneous non-Robertsonian translocations between wheat chromosomes and an alien chromosome. *Proc. 7th Intern. Wheat Genet. Symp.* 387~390.
- NAKATA N., Y. YASUMURO and M. SASAKI 1977. An acetocarmine-Giemsa staining of rye chromosomes. *Jpn. J. Genet.* **52**: 315~318.
- OSBORN, T. C., D. C. ALEXANDER and J. F. FOBES 1987. Identification of restriction fragment length polymorphism linked to genes controlling soluble solids content in tomato fruit. *Theor. Appl. Genet.* **73**: 350~356.
- OKAMOTO, M. 1957. A synaptic effect of chromosome V. *Wheat Inf. Serv.* **5**: 6.
- RILEY, R. 1960. The diploidization of polyploid wheat. *Heredity* **15**: 407~429.
- 1968. The basic and applied genetics of chromosome pairing. *Proc. 3rd Intern. Wheat Genet. Symp.* 185~195.
- and V. CHAPMAN 1958. Genetic control of the cytologically diploid behaviour of hexaploid wheat. *Nature* **182**: 713~715.
- SASAKI, M. 1952. A discussion on the mutual translocation of chromosomes in wheat from the stand point of breeding. *Japan. J. Breed.* **2** (suppl.): 9~10.
- SEARS, E. R. 1954. The aneuploids of common wheat. *Mo. Agr. Exp. Sta. Res. Bull.* **572**: 1~59.
- and M. OKAMOTO 1958. Intergenomic chromosome relationships in hexaploid wheat. *Proc. X Intern. Congr. Genet.* **2**: 258~259.
- YOUNG, N. D. and S. D. TANKSLEY 1989. Restriction fragment length polymorphism maps and the concept of graphical genotypes. *Theor. Appl. Genet.* **77**: 95~101.
- VEGA, C. and J. R. LACADENA 1982. Cytogenetic structure of common wheat cultivars from or introduced into Spain. *Theor. Appl. Genet.* **61**: 129~133.
- WATANABE, Y. 1962a. Studies on cytological instabilities of common wheat. *Bull. Tohoku Natl. Agric. Exp. Stn.* **23**: 69~152.
- 1962b. Meiotic irregularities in intervarietal hybrids of common wheat. *Wheat Inf. Serv.* **14**: 5~7.
- WORLAND, A. J. and C. N. LAW 1985. Aneuploidy in semi-dwarf wheat varieties. *Euphytica*

34:317~327.

- and S. PETROVIC 1988. The gibberellic acid insensitive dwarfing gene from the wheat variety Saitama 27. *Euphytica* **38**:55~63.
- ZELLER, F.J. 1973. 1B/1R wheat-rye chromosome substitutions and translocations. *Proc. 4th Intern. Wheat Genet. Symp.* 209~221.

日本の普通コムギ品種における転座の検出と同定

Abdelbagi Mukhtar ALI・中田 昇・富田因則・安室喜正

(鳥取大学農学部, 鳥取市, 〒680)

日本の普通コムギ品種における染色体構造の分化を明らかにするために, Chinese Spring (CS) を基準品種として, 日本品種における転座の存在を調査し, 検出できた転座の異同を調査し, 日本コムギ品種における転座の分布について考察した。

供試品種は日本品種育成に多く用いられた新中長, 農林 29 号, 伊賀筑後オレゴン, 白達磨, 江島神力の 5 品種, 及びイタリアの半矮性品種育成に関与した埼玉 27 号である。転座の存在は, CS を含む供試 7 品種間 21 組合せの F_1 個体を育成し, 減数分裂中期における多価染色体形成により確認した。染色体対合の観察は酢酸カーミン染色及び C-バンド染色により行った。

日本品種と CS との F_1 における染色体対合を酢酸カーミン染色により観察した結果 (Table 1), 新中長を除く 5 品種と CS との F_1 では農林 29 号の 6.7% から江島神力の 76.6% までの細胞で多価染色体が観察され, 5 品種が 1 または 2 個の相互転座を持つことが明らかになった。

新中長は CS との F_1 30 細胞では多価染色体が観察されず, CS と同じ染色体構造を持つと考えられる。

農林 29 号, 伊賀筑後オレゴン及び白達磨の 3 品種は CS との F_1 で 1 個の四価染色体を形成し, それぞれ 1 個の相互転座を持っていた。

江島神力は CS との F_1 で観察細胞 30 細胞中 1 細胞で同時に 1 個の三価染色体と 1 個の四価染色体を形成し, 2 個の相互転座を持っていた。

埼玉 27 号は CS との F_1 では 1 個の三価または四価染色体を形成したが, 多価染色体は C-バンド染色により濃いバンドをもつものともたないものに分類できた。そのため, 埼玉 27 号は 2 個の相互転座を持つと結論した。

多価染色体の C-バンドパターンにより, 白達磨は B ゲノム染色体間転座を, 農林 29 号と伊賀筑後オレゴンは A または D ゲノム内転座あるいは A, D ゲノム間転座を持つと推定した。江島神力は 2 個の B ゲノム染色体間転座を持ち, 埼玉 27 号は B ゲノム染色体と他のゲノム染色体との転座及び B ゲノム染色体が関与しない転座を持つと考えられる。

品種間 F_1 における染色体対合の観察により転座の異同を調査した結果 (Table 2), 白達磨の転座は江島神力に存在する 2 個の転座のひとつと, 伊賀筑後オレゴンの転座は埼玉 27 号に存在する 2 個の転座のひとつとそれぞれ同一の染色体が関与していた。さらに, 江島神力と埼玉 27 号との F_1 では四価染色体が最高 3 個観察され, 30 細胞中 4 細胞では六価染色体が観察された。両品種は互いに異なる 2 個の転座をもつが, 両品種で同じ染色体が転座に関与していた。農林 29 号の転座に関与した染色体は他の 4 品種で転座に関与した染色体とは異なっていた。

本研究において, 供試 6 品種中 5 品種に 9 染色体が関与した 7 個の相互転座が存在することが明らかになった (Fig. 2)。日本コムギ品種の転座の起源として次の 3 つが考えられる。(1) 在来種が長年保持してきたもの, (2) 品種育成に用いられた外国品種に由来するもの, および (3) 育成過程の偶発転座によるもの。14 個の転座部位のうち 7 個は B ゲノム染色体部位であった。外国品種においても B ゲノム染色体が転座に関与している例が多く, B ゲノム染色体は他の A 及び D ゲノム染色体より転座が起こり易いと考えられる。近年育成された多くの日本品種は, 埼玉 27 号を除く転座をもつ 4 品種と系統的に関連しているため, 転座を有する可能性が高い。そのため, 転座を含む染色体構造変異に関する情報は品種間交雑育種及び CS で開発された DNA マーカーの日本コムギ育種への利用に有用である。