Wheat Information Service
Number 78: 28 – 33 (1994)

Morphology and cytology of intergeneric hybrids of *Kengyilia gobicola* and *K. zhaosuensis* crossed with *Roegneria tsukushiensis*

Sun Gen-Lou, Yen Chi and Yang Jun-Liang

Triticeae Research Institute, Sichuan Agricultural University, Dujiangyan city, 611830, Sichuan, China

Summary

Two intergeneric hybrids were obtained from *Kengyilia gobicola* Yen et J. L. Yang and *K. zhaosuensis* J. L. Yang, Yen et Baum crossed with *Roegneria tsukushiensis*. Chromosome pairings were studied at metaphase I in the two hybrids. Meiotic configurations were 18.69 univalents + 11.56 bivalents + 0.04 trivalents for *K. gobicola* × *R. tsukushiensis*, and 18.56 univalents + 11.73 bivalents + 0.04 trivalents for *K. zhaosuensis* x *R. tsukushiensis*. Lagging chromosomes at anaphase I and II, tetrads with micronuclei were observed in these two hybrids. Chromosome bridges were found at anaphase I and II in *K. zhaosuensis* × *R. tsukushiensis*. The results indicated that *K. gobicola* and *K. zhaosuensis* share two same basic genomes with *R. tsukushiensis*.

Introduction

Kengyilia Yen et J. L. Yang is a new genus found in west China (Yen and Yang 1989, 1990). *Kengyilia gobicola* Yen et J. L. Yang, a hexaploid (2n = 42) (Sun et al. 1989) perennial grass, is distributed in Gobi Desert at the foot of Muztagata Mt., Xinjiang, China. This species has short, rod-like leaves that form tube-like structures and much hair on the adaxial epidermis of leaf blade. The adaxial epidermal surface of the blade is covered with a thick cuticule layer and bears few stomata. The deep root with dense root hair holds sand around it in the form of a sand sheath. The hairy spike reduces evaporation to protect the physiological activity of this important reproductive organ. These characteristics make *K. gobicola* a good drought resistant plant (Yen and J. L. Yang 1990).

Kengyilia zhaosuensis J. L. Yang, Yen et Baum, a hexaploid (2n = 42) (Sun et al. 1989, 1993), perennial plant, is distributed in Zhaosu country, Xinjiang.

K. gobicola and *K. zhaosuensis* are new species which were found in recent years. The karyotypes of them were reported by Yen and J.L. Yang (1989), and Sun et al. (1993).

Roegneria tsukushiensis (Honda) B. R. Lu, Yen et J. L. Yang, a popular grass growing along the fields and road-sides, is widely distributed in China, Korea and Japan (Ohwi 1965, Lu et al. 1990). This species is allohexaploid (2n = 42), which comprises three different genomes (Sakamoto 1964, Dewey 1984, Lu et al. 1990).

In an attempt to explore the biosystematic relationships of *K. gobicola* and *K. zhaosuensis* with *R. tsukushiensis*, the artificial hybrids were made from *R. tsukushiensis* crossed with *K. gobicola* and *K. zhaosuensis*. The morphological and cytological analyses of these hybrids are reported in the present paper.

Materials and methods

The species used for morphological analysis and intergeneric hybridizations in the present study were collected in 1987. The experimental materials are listed in Table 1.

Table 1. The experimental materials

Species	2n	Collection site	Collector	Code No.
Kengyilia gobicola Yen et J. L. Yang	42	Tashiquerqan, Xinjiang	Yen et al.	Y665
K. zhaosuensis J. L. Yang, Yen et Baum	42	Zhaosu, Xinjiang	Yen et al.	Y803
R. tsukushiensis	42	Yaan, Sichuan	Yang et al.	Y83017

Roegneria tsukushiensis (Honda) Lu B. R., Yen et J. L. Yang was used as male parent. The spikes of *Kengyilia gobicola* Yen et J. L. Yang and *K. zhaosuensis* J. L. Yang, Yen et Baum were emasculated and covered with cellulose bag. The hand-emasculated spikes were pollinated two days later by brushing maternal stigmas with newly broken anthers of the paternal species. Caryopses showing enlargement at 14 days were excised for embryo culture. Seedlings at the three leaves stage were transplanted into sand culture pots, watered with complete nutrient solution, and kept in low temperature room over summer.

Morphological characters were compared between the the parents and their F_1 hybrids.

For cytological observation, the young spikes were fixed in Carnoy's I solution (alcohol:acetic acid = 3:1), and stored in a refrigerator. Chromosome pairings were observed at the MI of the pollen mother cells (PMCs) using the aceto-carmine smear method. Photographs were taken by Olympus AD-10 camera system.

Voucher specimen of the parents and the F_1 hybrids have been kept in the nursery and the herbarium of Triticeae Research Institute, Sichuan Agricultural University.

Results

Production and morphology of F_1 hybrids: *K. gobicola* and *K. zhaosuensis* were used as female parents in crossing with *R. tsukushiensis*. The results are shown in Table 2. One well growing seedling was obtained by means of embryo culture for *K. gobicola* × *R. tsukushiensis* and *K. zhaosuensis* × *R. tsukushiensis*, respectively.

Table 2. The results of crosses between the two *Kengyilia* species and *R. tsukushiensis*

Combinations	No. of spikes crossed	No. of florets pollinated	Seed set No.	Seed set %	No. of embryos cultured	No. of plants obtained
K. gobicola × *R. tsukushiensis*	1	40	6	15	6	1
K. zhaosuensis × *R. tsukushiensis*	1	44	2	4.5	2	1

Eighteen morphological characters of the parents and the hybrids were observed and measured as shown in Table 3. Number of spikelets per spike and florets per spikelet in *R. tsukushiensis* are more than those in *K. gobicola* and *K. zhaosuensis*. Lengths of spike, spikelet, awn on lower and upper glumes, lemma and awn on lemma, and palea of *R. tsukushiensis* were longer than those of *K. gobicola* and *K. zhaosuensis*. The lower and upper glumes of *R. tsukushiensis* are as long as those of *K. gobicola*, while shorter than those of *K. zhaosuensis*. The lemmas and rachis of *K. gobicola* were pubescent, while those of *R. tsukushiensis* were glabrous. The lemmas of *K. zhaosuensis* was pubescent. The F_1 hybrids of *K. gobicola* x *R. tsukushiensis* and *K. zhaosuensis* × *R. tsukushiensis* were intermediate between their parents in morphology. Since *K. gobicola* and *K. zhaosuensis* are distributed in arid area of Xinjiang, they could not endure the summer of subtropic climate of Dujiangyan city, Sichuan, while *R. tsukushiensis* and its hybrids crossed with *K. gobicola* and *K. zhaosuensis* could adapt to this condition.

Cytology: The data of chromosome pairings at metaphase I of PMCs in the two cross combinations are shown in Table 4. The chromosome configurations are shown in Figures 1 to 10.

Both of the hybrids of *K. gobicola* × *R. tsukushiensis*, and *K. zhaosuensis* × *R. tsukushiensis* had 42 chromosomes. They had similiar meiotic pairing patterns. A large number of univalents were found in the two cross combinations, i. e., on average, 18.69 univalents per cell for *K. gobicola* × *R. tsukushiensis*, and 18.56 univalents per cell for *K. zhaosuensis* × *R. tsukushiensis*. The average number of bivalents were 11.56 with the range of 7 to 14 for *K. gobicola* × *R. tsukushiensis*, and 11.73 with the range of 8 to 14 for *K. zhaosuensis* × *R. tsukushiensis*. A low frequencies of trivalents were also observed in both combinations with the average of 0.04 per cell. The chiasmata frequencies in *K. gobicola* x *R. tsukushiensis* and *K. zhaosuensis* × *R. tsukushiensis* were 17.44 and 17.41, respectively. The lagging chromosomes at anaphase I and II, and tetrads with micronuclei were observed in both combinations. Chromosome bridges at anaphase I and II were found in the hybrid of *K. zhaosuensis* × *R. tukushiensis*.

Table 3. Morphological characteristics of *K. gobicola*, *K. zhaosuensis*, *R. tsukushiensis*, and their hybrids on eighteen characters

Character	*K. gobicola*	*K. gobicola* × *R. tsukushiensis*	*R. tsukushiensis*	*K. zhaosuensis* × *R. tsukushiensis*	*K. zhaosuensis*
No. spikes/plant	9.29±1.83	13.0±2.31	21.64±3.04	25.40±1.52	14.40±1.82
No. florets/spikelet	5.91±0.83	4.86±0.54	7.34±1.28	4.22±0.61	4.71±0.49
Length of spike (cm)	8.24±2.62	15.9±1.65	21.14±2.70	19.44±1.17	13.38±2.59
Length of spikelet (cm)	1.47±0.08	1.52±0.14	2.19±0.17	1.14±0.10	1.61±0.16
Length of the 1st glume (cm)	0.66±0.08	0.68±0.05	0.61±0.07	0.76±0.05	1.10±0.09
Breadth of the 1st glume (cm)	0.25±0.04	0.20±0.01	0.17±0.02	0.20±0.01	0.27±0.03
Length of awn on the 1st glume (cm)	0.07±0.03	0.07±0.03	0.80±0.39	0.21±0.05	0.10±0.05
No. nerves of the 1st glume	5.60±0.52	4.75±0.46	4.50±0.57	5.27±0.45	5.44±0.51
Length of the 2nd glume	0.57±0.10	0.57±0.04	0.53±0.06	0.66±0.06	1.03±0.07
Breadth of the 2nd glume	0.24±0.05	0.18±0.02	0.15±0.02	0.19±0.01	0.25±0.03
Length of awn on the 2nd glume (cm)	0.07±0.03	0.06±0.02	0.91±0.24	0.12±0.04	0.07±0.04
No. nerves of the 2nd glume	3.86±0.53	3.25±0.46	3.10±0.30	4.08±0.39	4.08±0.29
Length of the 1st lemma (cm)	0.80±0.06	0.86±0.03	0.93±0.05	0.86±0.03	0.96±0.13
Length of awn on the 1st glume (cm)	0.28±0.07	0.62±0.06	3.60±0.33	0.99±0.10	0.42±0.16
Length of palea (cm)	0.77±0.05	0.88±0.03	0.94±0.05	0.89±0.03	0.85±0.05
Hair on palea*)	++	++	– –	– –	+
Hair on rachis*)	+	+	– –	– –	– –
Form of palea	truncate	truncate	obtuse	truncate	truncate

*) ++: dense hair, +: sparse hair, – –: hairless

Table 4. The average meiotic pairings at metaphase-I in the intergeneric hybrids of *K. gobicola* × *R. tsukushiensis* and *K. zhaosuensis* × *R. tsukushiensis*

Cross combinations	No. of cells observed	I	II			III	Xta
			Total	Rod	Ring		
K. gobicola × *R. tsukushiensis*	55	18.69 (13–28)	11.56 (7–14)	5.76 (1–10)	5.80 (0–10)	0.04 (0–1)	17.44
K. zhaosuensis × *R. tsukushiensis*	104	18.56 (14–26)	11.73 (8–14)	6.13 (0–10)	5.60 (1–10)	0.01 (0–1)	17.41

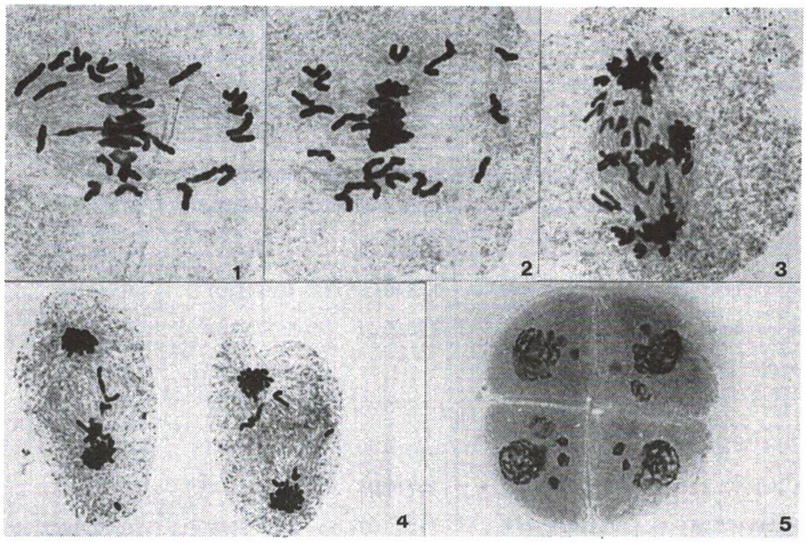

Fig. 1-5. Meiosis in the hybrid of *Kengyilia gobicola* × *Roegneria tsukushiensis*. 1: 23 univalents + 8 bivalents + 1 trivalent at MI. 2: 20 univalents + 11 bivalents at MI. 3: Lagging chromosomes at anaphase I. 4: Lagging chromosomes at anaphase II. 5: Tetrad with micronuclei

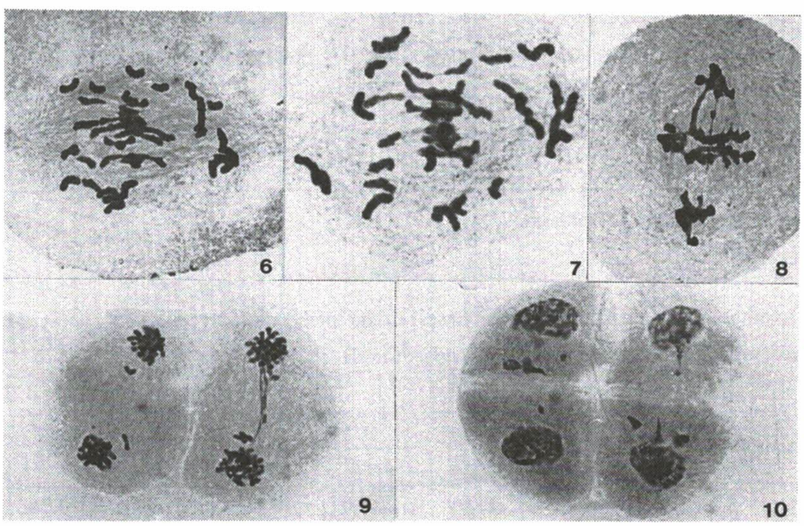

Fig. 6-10. Meiosis in the hybrid of *Kengyilia zhaosuensis* × *Roegneria tsukushiensis*. 6: 22 univalents + 10 bivalents. 7: 24 univalents + 9 bivalents. 8: Lagging chromosomes and chromosome bridge at anaphase I. 9: Lagging chromosome and chromosome bridge at anaphase II. 10: Tetrad with micronuclei

Discussion

K. gobicola and *K. zhaosuensis* are new species which were found in west China in recent years. Their genomes were not analysed. Their karyotypes showed that they possess a set of long chromosomes, which can be distinguished clearly from H, S, and Y genomes. The fourth and sixth chromosomes of karyotypes were satellite chromosomes which were similiar to those of P genome of *Agropyro*n (Yen et al. 1989, 1990). According to the karyotypes, Yen and J. L. Yang (1989, 1990) infer that *K. gobicola* and *K. zhaosuensis* have the P genome and two sets of other genomes.

R. tsukushiensis has the S, H and Y genomes (Sakamoto 1964, Dewey 1984, Lu et al. 1990). The frequencies of 11.56 and 11.73 bivalents per cell were found in the hybrids of *K. gobicola* and *K. zhaosuensis* crossed with *R. tsukushiensis* respectively. The results indicated that *K. gobicola* and *K. zhaosuensis* share two sets of genomes of *R. tsukushiensis* and the two genomes of *K. gobicola* and *K. zhaosuensis* have high homology with the two genomes of *R. tsukushiensis*.

Chromosome bridges at anaphase I and II were found in meiosis of *K. zhaosuensis* × *R. tsukushiensis*. It showed that paracentric inversion probably occurred between the genomes of *K. zhaosuensis* and *R. tsukushiensis*.

Reference

Dewey DR (1984) The genomic system of classification as a guide to intergeneric hybridization with perennial Triticeae. *In*: Gene manipulation in plant improvement. Ed: Gustafson JP Pleum Press New York, pp 209-279.

Lu BR, Yen C and Yang JL (1990) Cytological and morphological studies of *Agropyron tsukushiense* var. *transiens* of Japan, *Roegneria kamoji* of China and their artificial hybrids. Acta Bot. Yunnanica 13 (3): 237-246.

Ohwi J (1965) Flora of Japan. Smithsonian Institution, Washington.

Sakamoto S (1964) Cytogenetic studies in the tribe *Triticeae* I: A polyhaploid plant of *Agropyron tsukushiensis* var. *transiens* Ohwi found in a state of nature. Jpn J Genet 39: 393-400

Sun GL, Yen C and Yang JL (1990) Observations on chromosome numbers of perennial species of *Triticeae* from Xinjiang. Guihaia 10: 143-148.

Sun G L, Yen C and J L Yang (1993) Studies on karyotypes of 2 species in *Kengyilia* and 3 species in *Roegneria*. Acta Phytotaxonomica Sinica 31: 560-564.

Yang JL, Yen C and Baum BR (1992) *Kengyilia*: synopsis and key to species. Hereditas 116: 25-28.

Yan J (Yen C), and Yang JL (1990) *Kengyilia*, a new genus of tribe *Triticeae* of *Gramineae* from China. J Sichuan Agric Univ 8: 75-76.

Yen C and Yang JL (1990) *Kengyilia gobicola*, a new taxon from west China. Can J Bot 68: 1894-1897.

Wheat Information Service
Number 78: 34 – 38 (1994)

Crossability percentages of bread wheat landraces from Hunan and Hubei provinces, China with rye

Luo M. C.*, Yen C. and Yang J. L.

Triticeae Research Institute, Sichuan Agricultural University, Dujiangyan City, Sichuan 611830, P. R. China

Introduction

Our previous papers (Luo et al. 1992, 1993a, 1993b) reported the crossabilities of landraces from Sichuan, Shaanxi and Henan Provinces and the Tibet Region, China and their geographical distribution, and revealed that landraces with high crossability widely exist in the regions of Sichuan, Shaanxi and Henan, but rare in Tibet region. As the extendence of the previous ones, the present paper reports the crossabilities of landrace accessions from Hunan and Hubei Provinces, China.

Materials and methods

Ninety-four accessions of wheat landraces (*Triticum aestivum* L.) were grown from seeds, of which 44 landraces from Hunan Province and 50 landraces from Hubei Province, China were kindly provided by Mr. Shiqiang Yun of Crop Institute of Hunan Academy of Agricultural Sciences and Mr. Qichang Zhang of Institute of Modernization of Hubei Academy of Agricultural Sciences, respectively. The inbred line of Qinling rye (*Secale cereale* L.) was used as male tester in the crosses. The emasculation and pollination techniques were as reported earlier (Luo et al. 1992). Thirty days after pollination, the number of florets with and without seeds were recorded for each spike. The data are expressed as the percentage of successful crosses over the total number of florets pollinated. The *t*-test was adopted to detect the crossability differences between a wheat landrace and the control (Chinese Spring).

Results and discussion

As the landraces were tested separately in 1991-1992, the crossability percentage of Chinese Spring in the year was applied in the *t*-test.

1. The crossabilities of wheat landraces from Hunan Province: The crossability percentages with rye of 44 wheat landraces from Hunan Province, China were investigated in 1991 (Table 1). The crossability percentages of Chinese Spring with rye in 1991 (73.0%) was used for comparison with those of landraces.

* The present address: Department of Agronomy and Range Science, University of California, Davis, CA 95616, U.S.A.