6-24-1994

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ABSTRACT

The total of 865 accessions of Chinese bread wheat landraces (*Triticum aestivum* L.) has been investigated on their crossabilities with rye (*Secale cereale* L.), of which 121 landraces showed similar crossability to Chinese Spring, 50 accessions had much higher crossability than Chinese Spring, and 693 varieties were non-crossable with rye or had lower crossability than Chinese Spring. The analysis on the geographical distribution indicated that the landraces with high crossability occurred in most parts of China. Some utilization of high crossability resources was also discussed.

INTRODUCTION

Since the first study on crossability of wheat (*Triticum aestivum* L.) with rye (*Secale cereale* L.) by Backhouse (1916), much attention has been given to the character in its genetic structure and the agricultural application (Lein, 1943; Riley and Chapman, 1967; Falk and Kasha, 1981; Zeven, 1987; Luo *et al.*, 1992, 1993a, 1993b, 1994). Lein (1943) suggested that there were two pairs of gene controlling the crossability of bread wheat with rye. Sasaki and Wada (1966), and Riley and Chapman (1967) revealed that *kr1* located on the chromosome 5B, and *kr2* on chromosome 5A controlled crossability. Krowlow (1973) located *kr3* on chromosome 5D. Zeven (1987) summarized the crossabilities of some 1400 bread wheat varieties or lines. He indicated that most of the varieties or lines with high crossability percentage were landraces from China, Japan and Eastern Sibiria.

In 1950's, about 30,000 wheat landrace accessions were collected in China, and much attention has been given regarding their agronomic traits and disease resistance. From 1985 on, we have worked on the crossabilities of Chinese hexaploid wheats. The results revealed that one new gene *kr4* also controls the wheat-rye crossability, and was located on the chromosome 1A (Luo *et al.*, 1989; Zheng *et al.*, 1992). The present paper summarized the results of our investigation on the crossabilities of Chinese bread wheats with rye.

MATERIALS AND METHODS

A total of 864 landrace accessions of Chinese bread wheat (*Triticum aestivum* L.) was involved in the investigation. These landraces were collected in 1950's and conserved by the provincial academic organizations in China (Table 1). the wheat landraces were crossed with rye (*Secale cereale* L. cv. Zinling rye, used as the male tester). The emasculation and pollination techniques were the same as the previous paper (Luo *et al.*, 1992). Thirty days later following pollination, the number of florets with and without seeds were recorded for each spike included in the experiment. The percentage of successful crosses over the total numbers of florets pollinated were used in a *t*-test, which was adopted to detect the crossability difference between a wheat landrace and the control (Chinese Spring).

RESULTS AND DISCUSSION

The tests on the crossability percentages have been carried out during 1985-1991. Eight hundred and sixty-four landraces of Chinese common wheat (*Triticum aestivum* L.), which were from Sichuan, Shaanxi, Henan, Gansu, Yunnan, Guizhou, Hunan, Shanxi, Hebei, and Tibet have been included in the investigation of wheat-rye crossability. For delimitating the differences among years, Chinese Spring was selected as a control. It is known that Chinese Spring possesses the genotype of *kr1kr1kr2kr2kr3kr3Kr4Kr4*. In seven continuous years, the percentages of seed set in crosses of Chinese Spring with

Table 1. The crossability types and their distribution in the Chinese bread wheat landraces

Original locality	Group 1 No. of varieties	Group 1 %	Group 2 No. of varieties	Group 2 %	Group 3 No. of varieties	Group 3 %	Group 4 No. of varieties	Group 4 %	Total	Source
Sichuan	65	36.72	62	35.03	34	19.21	16	9.09	177	Ms Zhou and Ms Jiang, Sichuan Academy of Agricultural Sciences
Shaanxi	19	26.39	29	40.28	17	23.61	7	9.72	72	Germplasm Laboratory, Shaanxi Academy of Agricultural Sciences
Henan	8	17.39	18	39.13	13	28.26	7	15.22	46	Prof. M.Z. Ren, Henan Academy of Agricultural Sciences
Gansu	16	33.33	16	35.42	14	27.08	2	4.17	48	Mr. W.G. Li, Gansu Academy of Agricultural Sciences
Yunnan	38	62.30	22	36.07	1	1.64	0	0.00	61	Mr. S.Y. Wu, Yunnan Academy of Agricultural Sciences
Guizhou	13	33.33	18	46.15	6	15.38	2	5.13	39	Mr. X.B. Fang, Guizhou Academy of Agricultural Sciences
Hunan	8	18.18	15	34.09	14	31.82	7	15.91	44	Mr. S.Q. Yun, Hunan Academy of Agricultural Sciences
Shanxi	13	19.40	36	53.73	13	19.40	5	7.46	67	Prof. H.C. Xu, Shanxi Academy of Agricultural Sciences
Hebei	8	28.57	12	42.86	4	14.29	4	14.29	28	Prof. F.R. Sun, Hebei Academy of Agricultural Sciences
Tibet	236	83.69	41	14.54	5	1.77	0	0.00	282	Collections in 1988, sponsored by IBPGR, FAO, UN.
Total	424	49.07	269	31.13	121	14.00	50	5.79	864	

rye were 82.1%, 74.0%, 80.8%, 78.2%, 73.6%, 71.9%, and 73.0%. The weighted average being 75.9%. There is no significant difference between the maximum (82.1%) and the minimum (71.9%) ($tvt_{0.05}$). As the landraces were tested separately in the different year(s), the crossability percentage of Chinese Spring in the year was applied in the *t*-test.

According to the results of *t*-tests and Lein's (1943) suggestion, the landraces were divided into four groups.

Group 1: The crossability percentages were lower than 5%, therefore being very difficult to cross with rye or non-crossable. There is no recessive *kr* allele in this group.

Group 2: The crossability percentages were 5% or higher, but significantly lower than that of Chinese Spring. There exists one or two pairs of recessive *kr* genes.

Group 3: having the similar crossabilities to Chinese Spring. This group possesses recessive *kr1*, *kr2* and *kr3* genes.

Group 4: showing much higher crossability percentages than Chinese Spring, and having the genotype of *kr1kr1kr2kr2kr3kr3kr4kr4*.

The high frequency of easily crossable materials occurred among the landraces investigated. Of the 864 landraces, 121 varieties showed similar crossability to Chinese Spring, 50 landraces had significantly higher crossability than Chinese Spring. 424 landraces were non-crossable or very difficult to cross with rye, 269 varieties were crossable with rye, but their crossabilities were much lower than that of Chinese Spring (Table 1).

From Table 1, 14% of landraces investigated had similar crossability to Chinese Spring (Group 3). The landraces belonging to this group frequently occurred in Hunan, Henan, Gansu, Shaanxi, Sichuan, Shanxi, Guizhou and Hebei, but rare in Yunnan and Tibet. Of the 864 landraces, 5.8% showed much higher crossability percentages than Chinese Spring (Group 4). The higher crossability landraces were from Hunan, Henan, and Hebei Provinces of China. This area appears to be the center of geographical distribution of recessive *kr4* gene. There was no distribution of recessive *kr4* gene in Yunnan and Tibet regions.

The results of this investigation revealed that Chinese wheat landraces are rich in high crossability resources. It is known that Chinese Spring, a strain of a landrace in Sichuan province of China, has been selected as a standard cultivar in the genetic study of wheat primarily for its easy crossability with rye. It is believed that the landraces with much higher crossability than Chinese Spring from China may make further contribution in the aspects of genetic studies and the practices of transferring alien genetic materials from some species of genera in Triticeae into wheat. As a representative of high crossability germplasm, "J-II" has been successfully used in the crosses of wheat with *Psathyrostachys huashanica* Keng and *Roegneria ciliaris* (Trin.) Nevski (Sun, 1992, Wang, personal communication).

Acknowledgements - The authors are highly thankful to the National Science Foundation of China and IBPGR, FAO, UN, for their financial supports.

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