

SYSTEMATIC STUDY OF *SECALE CEREALE* IN IRAN

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Abstract

Secale cereale (rye) with its vitally importance can have a marked place in the world cereal production, particularly in North Europe. This study concerns morphology, taxonomy and cytotaxonomy of this species in Iran. Based on the evaluation of 12 qualitative and quantitative morphological characters and using phenetic analysis, it was revealed that, *S. cereale* occurs in Iran with two subspecies, namely, *cereale* and *ancestrale*. Our results showed that the rachis fragility could be considered as a distinctive character between the above taxa. The cytotoxicomic observations of 10 populations showed that all the Iranian *S. cereale* gene pool belongs to the diploid ($2n=14$) level. Only one population showed two B-chromosomes.

Key words: *Secale cereale*, Rye, Systematic, Cytotaxonomy, Iran

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Introduction

Despite being one of the world's most important cereals, *S. cereale* L. grows as an annual or biennial weed in wheat and barley fields or even wild in Iran (NASERNAKHAEI 2003). This species belongs to the tribe Triticeae (Poaceae), described by Linnaeus (LINNAEUS 1753, TZVELEV 1989), has a wide range of distribution all around the world (FREDERIKSEN & PETERSEN 1998). A cytotaxonomic review on the species from 1974 up to now, showed diploid numbers 14, 15, 21, 28 and 29 for this species, although $2n=14$ is the dominant one (GOLDBLATT 1981, 1984, 1985, 1988; GOLDBLATT & JOHNSON 1990, 1991, 1994, 1996, 1998; KHUSH & STEBBINS 1961). In addition 1-6 B-chromosomes have been reported for this species (FREDERIKSEN & PETERSEN 1998).

Materials and methods

Our morphological studies have been carried out on 40 accessions collected throughout the country and a total number of 69 herbarium specimens from the herbaria "IRAN" (Plant Pests & Diseases Research Institute Herbarium), "TARI" (Research Institute of Forests & Rangelands Herbarium), "THU" (Herbarium of Tehran University) and "HIU" (Herbarium of Isfahan University), from which 14 populations were selected as typical indicator for more studies using morphological examination (Table 1). Each accession or herbarium specimen was considered as one OTU (Operation Taxonomic Unit) and the phenetic analysis was performed against 12 quantitative and qualitative characters with two or three states (Table 2). To estimate specimens similarity indicated by morphological characters Jaccard and simple matching coefficient were determined. The resulting data matrix (Table 2) was used for cluster analysis using Percent disagreement, UPGMA (Unweighted pair-group average). A PCA (Principal Component Analysis) analysis was performed on morphological data and the most variable characters were also determined and finally, ordination of the species was performed based on the first three PCA axes. Statistical analyses were done using the software STATISTICA (1999). The phenetic observations were compared with the literature and used to construct a taxonomic key for the subspecies of *S. cereale* occurring in Iran.

Table 1. Voucher and geographic distribution details of accessions of *S. cereale* sampled in this study

Ser. No.	Taxon	Herbarium No.	Locality	Date	Collector	Alt. (m)
1	B-43-CER	TARI-27932	Zanjan: 50 Km to SE. Zanjan, Soltaniyeh	24.6.1960	H. Pabot	1800
2	B-42-CER	TARI-27933	Mazandaran: N. Kandavan	27.7.1960	H. Pabot	2180
3	E-3-CER	IRAN-21459	Mazandaran: Chalus, Pol-e Zanguleh	1948	Rechinger & Manuchehri	-
4	B-33-CER	TARI-22787	Tehran: Homand-e Absard	21.6.1971	Mousavi	1960
5	B-44-AN	TARI-411	E. Azarbaijan: 35-40 Km to Haris	21.7.1987	M. Olfat & H. Fathi	2325 & 2375
6	B-24-AN	TARI-19324	Tehran: Kondar, 34 Km to NE. Karaj	24.6.1974	Amin & Bazargan	2000
7	B-34-CER	TARI-77543	Yazd: Taft to Dehshir, Aliabad	31.5.1996	Mozaffarian	ca. 2400
8	B-35-CER	TARI-23516	Tehran: Karaj to Kalak	20.7.1971	Mousavi	1600
9	B-32-CER	TARI-1642	Kerman: Kuh-e Hezar, 20 Km SW. Rayen	4.6.1977	J.R. Edmondson & A.G. Miller	2700
10	B-23-AN	TARI-7105	Golestan: Golestan forest, Almeh	24.8.1972	H. Forooghi	1680
11	B-29-CER	TARI-27931	Azarbaijan: 30 Km to NE. Sarab	28.8.1960	H. Pabot	2500
12	I-9-CER	HIU-14708	W. Azarbaijan: Orumiyeh, Janyan	28.5.2001	Rahiminejad	1770
13	I-13-CER	HIU-14712	Lorestan: 40 Km to Aligudarz (from Khomein)	26.5.2001	Rahiminejad	1940
14	I-21-CER	HIU-14719	Kordestan: 65 Km to Sanandaj from Kamyaran	27.5.2001	Rahiminejad	1680

Table 2. Morphological characters & data matrix used in PCA of *S. cereale* populations in Iran

Character	Specimen													
	No.													
	B-43-CER	B-42-CER	B-44-AN	B-24-AN	B-23-AN	E-3-CER	B-33-CER	B-34-CER	B-35-CER	B-32-CER	B-29-CER	I-9-CER	I-13-CER	I-21-CER
Glume length, mm	1	1	1	2	1	1	1	1	1	1	1	1	1	1
Glume width, mm	2	1	1	2	1	2	2	2	2	2	1	2	1	2
Length of glume awn, mm	1	1	3	1	2	2	3	2	2	1	2	3	2	1
Lemma length, mm	1	2	1	1	1	1	2	2	2	2	1	1	1	2
Lemma width, mm	2	2	1	1	1	1	2	3	2	3	1	2	2	3
Length of lemma awn, mm	2	2	1	1	1	2	1	2	1	2	2	2	2	3
Length of bristles on the lemma keel, mm	1	1	1	1	2	1	1	1	1	1	1	1	1	1
Palea length, mm	2	2	2	1	1	2	2	2	1	2	1	1	2	2
Palea width, mm	1	2	3	1	1	1	2	3	2	3	1	2	2	2
Spike tough: 1 More or less fragile: 2	1	1	2	2	2	1	2	1	1	1	1	1	1	1
Densely haired below the spike: 1 With some hairs below the spike: 2 Glabrous: 3	3	1	3	3	3	2	2	2	2	3	2	3	2	3
Two spiklets: 1 Three spiklet: 2	2	2	2	2	2	2	1	1	2	1	1	2	2	1

The diploid chromosomes were counted from the root tips treated in cold water for 24 hours and fixed in ethanol and acetic acid (3:1) and hydrolyzed with 5N HCl for 7 min. and finally, squashed in aceto-orcein stain (FUKUI 1996).

Results and Discussions

In spite of enormous morphological differences, the 10 examined accessions of *S. cereale* in this study showed the diploid level ($2n=14$) (Fig. 1a & Table 3). These results are in accordance with the other chromosomal reports for this species (GOLDBLATT 1981, 1984, 1985, 1988; GOLDBLATT & JOHNSON 1990, 1991, 1994, 1996, 1998), although its tetraploid cytotype has been reported (FREDERIKSEN & PETERSEN 1998). The karyotypic observations have showed that chromosome morphology patterns were the same among under studied populations. Although there were two additional B-chromosomes in the sec. 7 (Fig. 1b & Table 3).

Based on the results of this study, it can be concluded that morphological variability encountered in *S. cereale* in Iran is not a matter of different karyotypic patterns.

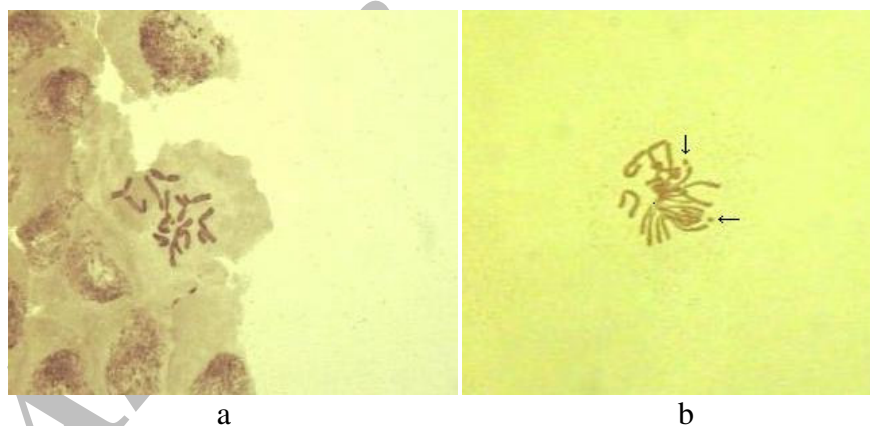


Fig. 1. (a) Somatic chromosome numbers ($2n=14$) in *S. cereale*, (b) somatic cell in the sec. 7 showing 2 B-chromosomes.

tion details of accessions of *S. cereale* sampled in
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Locality	Chromosomal No.	No. of observation slide
2 Km to Kalibar	2n=14	15
after Ahar, Shindare	2n=14	14
to Sanandaj	2n=14	15
z, begining of Ahar road	2n=14	10
after Ahar, Ahar to	2n=14+2B	18
tiari: Shahr-e-Kord,	2n=14	10
z, Zanjirbolagh,	2n=14	11
z, Khazarluo	2n=14	15
Divandare from	2n=14	15
to Tabriz	2n=14	14

Both the clustering (Fig. 2) and PCA (Fig. 3) analyses revealed the presence of 2 main groups which in general, are in agreement with FREDERIKSEN & PETERSEN (1998) groupings, suggesting *S. cereale* species with two subspecies, namely, *cereale* and *ancestrale* Zhuk. Cluster analysis show the first main cluster (Fig. 2) (11 OTUs) includes *S. cereale* subsp. *cereale* populations and the other (3 OTUs) includes *S. cereale* subsp. *ancestrale*. This agreed with FREDERIKSEN & PETERSEN's (1998) taxonomic treatment. But these characters sometimes can't use in evaluation of these two taxa (unpublished data of authors).

BOISSIER (1879) and BOR (1970) in their accounts on the species in Iran, described *S. cereale* as an annual plant possessing tough spike rachis, while PARSA (1950) believed the species has fragile rachis with 2-3 florets in each spikelet. Both descriptions are in accordance with FREDERIKSEN & PETERSEN (1998) in part(1950) believed the species has fragile rachis with 2-3 florets in each spikelet. Both descriptions are in accordance with FREDERIKSEN & PETERSEN (1998) in

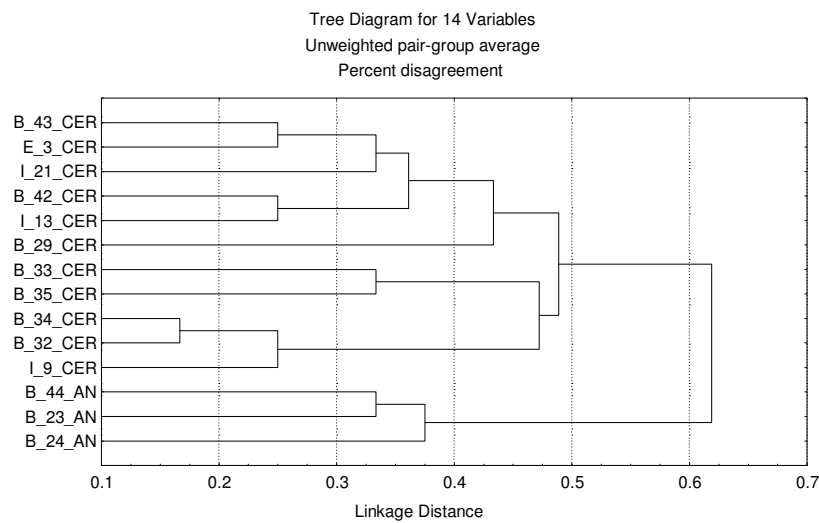


Fig. 2. UPGMA cluster analysis of morphological characters. For abbreviations see Table 1.

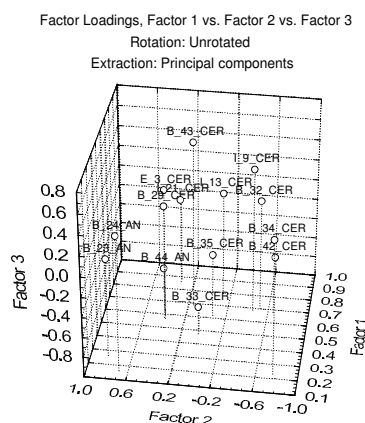


Fig. 3. PCA ordination (3 axes) of *S. cereale* accessions based on morphological characters. For abbreviations see Table 1.

part who described *S. cereale* as possessing: "Rachis tough or partly fragile, rarely totally fragile". The taxonomic literature regarding flora of Iran showed that, *S. cereale* has always been considered with no infraspecific taxa. BOR (1970) in his treatment on the flora of Iran, reported *S. segetale* (Zhuk.) Roshev. having fragile spikes in the 1/3 of the terminal part and *S. afghanicum* (Vavilov) Roshev. with a totally fragile spike. This study showed that, there were only few specimens among our materials that could be determined as *S. segetale*, while based on FREDERIKSEN & PETERSEN's (1998) monograph, these are fairly fixed in the range of *S. cereale* subsp. *ancestrale* Zhuk. In addition, there was no examined specimen showing a totally fragile spike which is the diagnostic character of *S. afghanicum*. Considering the descriptions for *S. afghanicum* by BOR (1970) and MOBAYEN (1975) comparing with that of *S. cereale* subsp. *ancestrale* by FREDERIKSEN & PETERSEN (1998) it becomes evident that in fact these descriptions refer to same taxon. Respecting the Priority law *S. cereale* subsp. *ancestrale* Zhuk. Trudy Prikl. Bot. 19, 2: 54 (1928) is to be considered as the correct name and *S. afghanicum* (Vavilov) Roshev., Trudy Bot. Inst. Akad. Nauk SSSR, ser. 1, Fl. Sist. Vyss. Rast. 6: 139 (1947) as its synonym; as treated by FREDERIKSEN

& PETERSEN (1998) Thus, we accepted *S. cereale* including two subsp., namely, *cereale* and *ancestrale* Zhuk. in Iran (Fig. 4), as follow:

***Secale cereale* L. Sp. Pl.: 84. 1753**

Herbaceous plants, annual, with culms 43-187.5 cm, rachis tough or partly fragile, spike 2.5-22.9 cm, awn of glumes 0-3.2 mm, awn of lemma 10.5-100 mm, bristles on lemma keel usually strongly developed 0.4-1.6 mm, anthers 5-9 mm. Plants mostly obligate allogamous:

- Rachis tough. Cultivated plants *S. cereale* subsp. *cereale*
- Rachis more or less fragile. Wild or weedy plants *S. cereale* subsp. *ancestrale*



Fig. 4. Distribution map of *S. cereale* L. subsp. *cereale* (●) and subsp. *ancestrale* Zhuk. (○).

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