

Notes on *Aegilops cylindrica* (Triticeae, Poaceae) in Iran

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Abstract

The present paper deals with the study of the taxonomy of one hundred accessions of *Aegilops cylindrica* collected all around the country, and also Iranian materials and type specimens and related species housed in the Natural History Museum Vienna (W), the Botanic Garden and Botanical Museum Berlin (B), were studied morphologically. The results showed that morphological traits such as length of spike, length of awn, number of spikelet in each spike, presence/absence of hair on spikelets and rachis were highly variable among the studied materials. Based on the results of this study *A. cylindrica* was recognized as having three varieties, all new records, for Iran.

Key words: *Aegilops cylindrica*, Triticeae, Poaceae, Taxonomy, Iran

Introduction

Aegilops cylindrica Host, an annual wild grass and almost close relative to *Triticum aestivum* L. (bread wheat), occurs throughout Mediterranean, Middle East and Asiatic regions (Linc *et al.*, 1999; Slageren, 1994; Karataglis, 1989). This species with a chromosomal formula of $2n = 4x = 28$ (DDCC) has been considered as an allotetraploid species resulted from a natural hybridization between *A. caudata* L. ($2n = 2x = 14$, CC) and *A. tauschii* Coss. ($2n = 2x = 14$, DD) (Linc *et al.*, 1999; Karataglis, 1989). Jaaska (1978) suggested that this species originated from east parts of Turkey, where the distribution areas of its putative parents might had been overlapped.

In his account Tzvelev (1976) recognized four varieties for *A. cylindrica*: *cylindrica*, *aristulata* (Zhuk.) Tzvel., *pauciaristata* Eig. and *prokhanovii* Tzvel. occurring in (the former) Soviet union (USSR); a fifth one, i. e., var. *rumelica* was added by Velenovsky for Flora Bulgarica (Velenovsky 1891). Bor (1970) recognized this species with no infra-specific subdivisions for the Flora Iranica areas (Iraq, Afghanistan and NW, W of Iran). Literature review shows that the Iranian materials of this species were the subject of taxonomic (Keshavarzi *et al.*, 2006; Arzani *et al.*, 2006; Kharazian, 2008), molecular cytogenetic and C-banding (Linc *et al.*, 1999; Bordbar *et al.*, 2011), isozyme (Jaaska, 1981), and inter-generic hybridization (Morrison *et al.*, 2002) studies. *Aegilops cylindrica* is also important from the breeding point of view, due to the gene flow between this species and *T. aestivum* (Guadagnuolo *et al.*, 2001).

This study aims to review the taxonomic status of *A. cylindrica* in Iran.

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Materials and Methods

A selection of 25 representatives (Table 1) belonging to *Aegilops cylindrica* from 100 accessions collected during the years 1996-2000 all around Iran were studied. The selected accessions included all distribution areas and main phenotypic variations. In order to provide enough plant materials for the morphological and taxonomic studies, the accessions were grown in the research field of the University of Isfahan. Voucher specimens are deposited in the herbarium of the University of Isfahan (HUI). In addition, all the related materials including the Iranian specimens collected for this study, type specimens of *A. cylindrica* var. *cylindrica* (W 2284), *A. cylindrica* var. *pauciaristata* (W 1426), *A. cylindrica* var. *rumelica* Velen. (W 5377) and two parental species i. e. *A. tauschii* (W 1973-0008961, W 1970-0016311) and *A. caudata* (W 0000441) housed in the Natural History Museum Vienna (W) and the Botanic Garden and Botanical Museum Berlin (B) were studied.

Table 1. List of Iranian *Aegilops cylindrica* accessions studied taxonomically

| No. | Accession Number | Locality |
|-----|------------------|---------------------------------------------------------------------------------------------------|
| 1 | Ag. 43 | Lorestan: Khorram Abad to Sepidasht, 1900 m, Rahiminejad and Sahebi |
| 2 | Ag. 59 | Fars: Dasht Arzhan, 2030 m, Rahiminejad and Sahebi |
| 3 | Ag. 108 | Kurdistan: Saqez to Marivan, 1500 m, Rahiminejad and Sahebi |
| 4 | Ag. 148 | Azərbayjan: 15 km remain to Ahar from Tabriz, 1550 m, Rahiminejad and Sahebi |
| 5 | Ag. 173 | Kurdistan: Piranshahr to Sardasht, 1200 m, Rahiminejad and Sahebi |
| 6 | Ag. 240 | Kurdistan: Boukan to Mahabad, 1490 m, Rahiminejad and Sahebi |
| 7 | Ag. 262 | Azərbayjan: Urmieh, 1332 m, Rahiminejad and Sahebi |
| 8 | Ag. 84 | Chaharmahal va Bakhtiari: Lordegan, Deh Soukhteh, 1770 m, Rahiminejad and Sahebi |
| 9 | Ag. 90 | Kurdistan: Sanandaj to Sonqor, 1620 m, Rahiminejad and Sahebi |
| 10 | Ag. 106 | Azərbayjan: Ahar to Kalibar, 1430 m, Rahiminejad and Sahebi |
| 11 | Ag. 470 | Kohgiluyeh va Boyer-Ahmad: Yasouj to Babameydan, 1180 m, Hosseini and Saeedi, (HUI 17985) |
| 12 | Ag. 476 | Kohgiluyeh va Boyer-Ahmad: Yasouj to Lordegan, Gharah village, 1950 m, Hosseini and Saeedi |
| 13 | Ag. 478 | Alborz: Karaj to Chalous, Marzan Abad, 500 m, Hosseini and Saeedi |
| 14 | Ag. 474 | Isfahan: Semirom, 2300 m, Hosseini and Saeedi |
| 15 | Ag. 479 | Khorasan: Azadshaher to Bojnourd, 1450 m, Hosseini and Saeedi |
| 16 | Ag. 484 | Khorasan: Shirvan to Mashhad, 1090 m, Hosseini and Saeedi |
| 17 | Ag. 488 | Khorasan: Neyshabour to Sabzevar, 1080 m, Hosseini and Saeedi |
| 18 | Ag. 489 | Khorasan: Sabzevar to Shahroud, Mayami, 1120 m, Hosseini and Saeedi |
| 19 | Ag. 490 | Tehran: Firouzkooh to Tehran, 1810 m, Hosseini and Saeedi |
| 20 | Ag. 497 | Hamedan: Hamedan to Assad Abad, 2140 m, Rahiminejad and Saeedi |
| 21 | Ag. 509 | Azərbayjan: Urmieh to Sero, 1286 m, Rahiminejad and Saeedi |
| 22 | Ag. 516 | Azərbayjan: Ahar to Kalibar, 35 km remain to Kalibar, 1716 m, Rahiminejad and Saeedi, (HUI 17986) |
| 23 | Ag. 576 | Golestan: Golestan forest, 650 m, Hosseini and Saeedi |
| 24 | Ag. 497 | Hamedan: Hamedan to Assad Abad, Assad Abad neck, 2140 m, Rahiminejad and Saeedi |
| 25 | Ag. 486 | Khorasan: Ashkhaneh to Bojnourd, 850 m, Rahiminejad and Saeedi |

In addition, to certify the ploidy levels of the studied materials, all the accessions were chromosomally examined from the root tips stained in aceto-orcein by squash method (unpublished data). In order to make a comparison among the materials under study, 20 morphological characters (16 quantitative and 4 qualitative) cited in the relevant literatures were evaluated (Table 2).

Table 2. Quantitative and qualitative characters considered in study of *Aegilops cylindrica* varieties in Iran (in quantitative characters means have calculated)

| No. | Character | <i>A. cylindrica</i> | <i>A. cylindrica</i> | <i>A. cylindrica</i> |
|-----|---------------------------------------------------------------|---------------------------|----------------------------|-------------------------|
| | | var. <i>cylindrica</i> | var. <i>prokhanovii</i> | var. <i>rumelica</i> |
| 1 | Length of spike (cm) | 9.36 | 8.1 | 5.22 |
| 2 | Length of spikelet (mm) | 10.66 | 9 | 10 |
| 3 | Length of lower most glume (mm) | 9 | 9.1 | 8.5 |
| 4 | Width of lower most glume (mm) | 3.66 | 3.4 | 3.1 |
| 5 | Length of upper most spikelet awn (cm) | 5 | 4.8 | 6.63 |
| 6 | Length of lower most spikelet awn (mm) | 2 | 2.7 | 3 |
| 7 | Length of second spikelet awn (mm) | 5.33 | 3 | 10.7 |
| 8 | Length of second spikelet glum (mm) | 10.33 | 7 | 7.2 |
| 9 | Length of caryopsis (mm) | 8.33 | 6 | 5.5 |
| 10 | Width of caryopsis (mm) | 2.16 | 2 | 2 |
| 11 | Number of florets in spikelet | 3.66 | 3 | 3 |
| 12 | Number of seeds in spikelet | 1.66 | 2 | 2 |
| 13 | Number of spikelets in each spike | 8 | 8 | 5.1 |
| 14 | Length of second spikelet awn/ Length of second spikelet glum | 0.51 | 0.42 | 1.48 |
| 15 | Length of uppermost spikelet awn/ Length of spike | 0.53 | 0.59 | 1.27 |
| 16 | Length of lower most spikelet awn/ Length of lower most glume | 0.22 | 0.29 | 0.35 |
| 17 | Compact hair on rachis (absent: - / present: +) | - | + | - |
| 18 | Hair on glume (absent: - / present: +) | - | + | - |
| 19 | Spike shape (oblong: - / cylindrical: +) | + | + | - |
| 20 | Spike colour (green: - / brown: +) | - | + | - |

Results and discussion

The results of this study showed that the geographical distribution of *Aegilops cylindrica* in Iran was restricted to an area from northwest (Azarbaijan province) eastwardly along Elburz mountains toward northeast (Khorasan province) and southwardly along Zagros mountains toward southwest of Iran with an elevation ranging from 500-2300 m (Figure 1). In comparison with Bor (1970) our observations expanded the distributional range of this species in Iran. Jaask (1978) considered *A. cylindrica* as a Mediterranean element, where the two putatively diploid progenitor i. e. *A. caudata* and *A. tauschii* underwent the hybridization and allopolyploidy processes to create *A. cylindrica* in Turkey; which then emigrated to Europe and Iran.

In *A. cylindrica* usually the length of awns gradually increased from lowermost spikelet towards the uppermost one in each spike, so that the uppermost spikelet showed the longest awn. One of the studied accessions collected from NW of Iran showed interesting state in which not only was the awn of the uppermost spikelet the longest but also was longer than the total spike's length. On the other hand, in this specimen all the spikelets in the middle part of the spike showed awns longer than the accessions collected from the other areas. The majority of accessions studied possessed spikes with an average of eight spikelets per spike, however, the least number of spikelets per spike (five spikelets) was observed in above (Table 2).

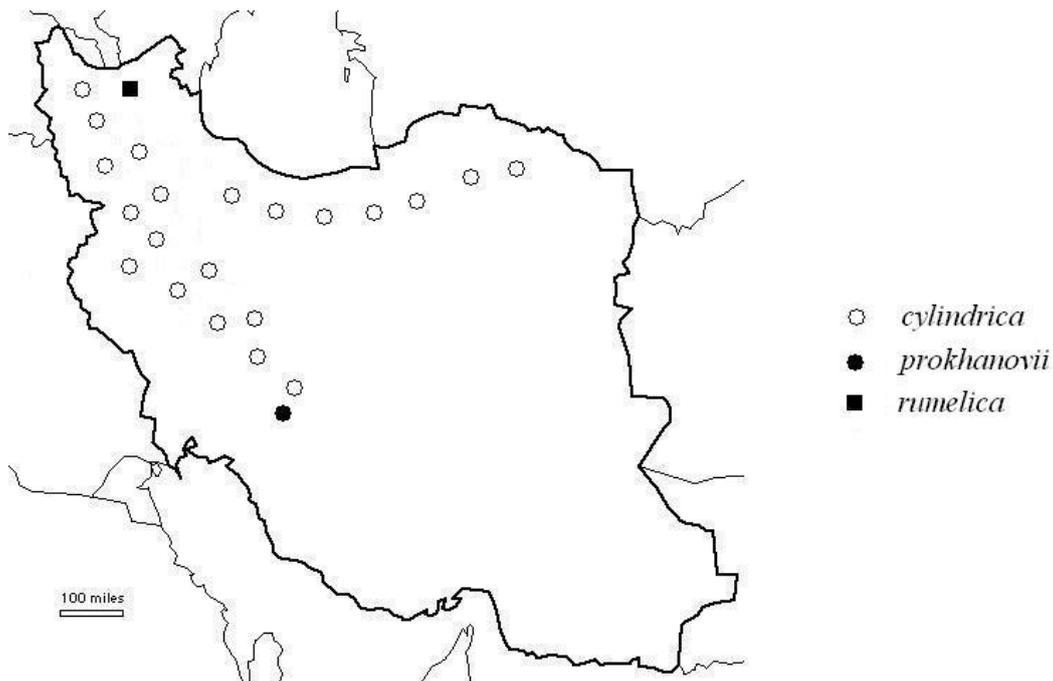


Figure 1. A distribution map of *Aegilops cylindrica* varieties in Iran

Also, this study showed that spike shape among the studied materials vary from oblong to cylindrical. All plants having the longest awn and the least spikelets number per spike showed oblong spike shape compared with those having cylindrical spike. These characters were diagnostic features for var. *rumelica* which we collected from Azarbaijan (Ahar to Kalibar, 35 km to Kalibar, 1716 m) (see Figures 2C, 3, Tables 1, 2).

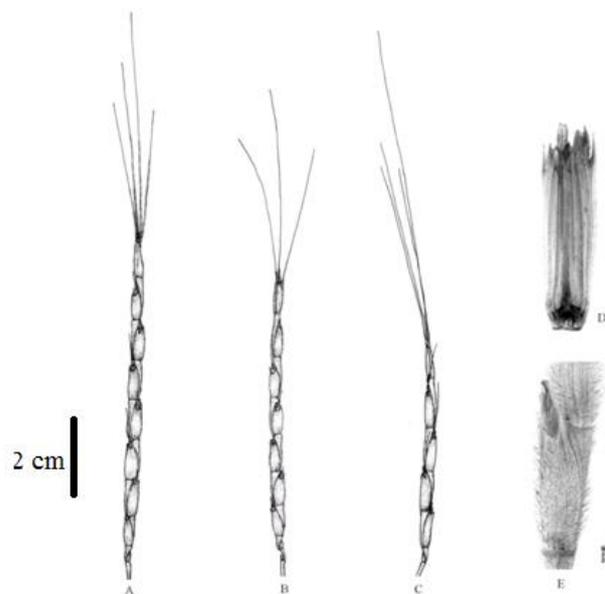


Figure 2. *Aegilops cylindrica* varieties. A. *cylindrica* (HUI 17989); B. *prokhanovii* (HUI 17985); C. *rumelica* (HUI 17986); D. Scabrid surface of glume in var. *cylindrica* and var. *rumelica*. E: Densely pilose in var. *prokhanovii*.

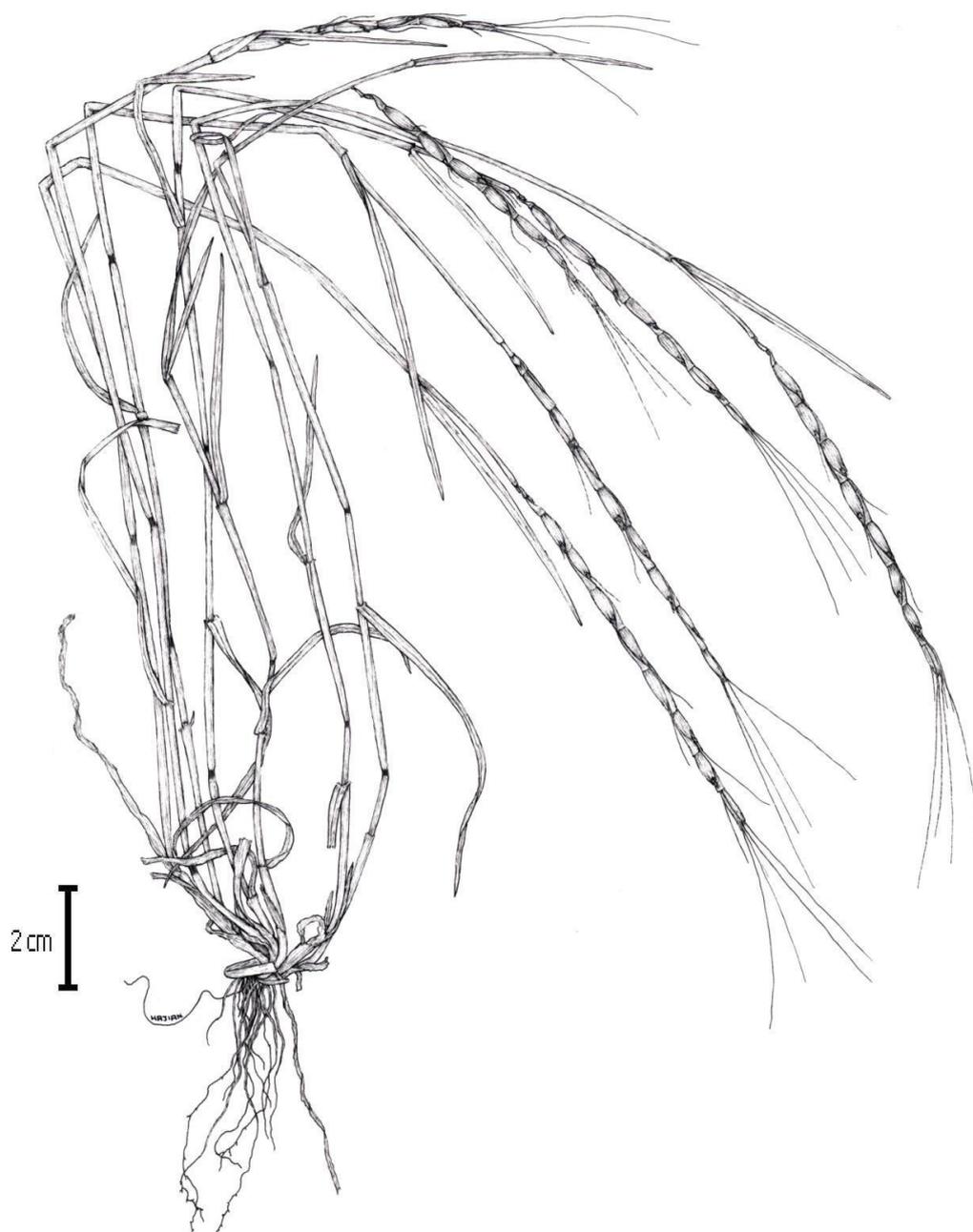


Figure 3. A general habit of *Aegilops cylindrica* Host (var. *cylindrica*)

The presence of scabrid glumes and rachis was the normal traits in *A. cylindrica*; nevertheless a collected accession from Yasouj to Babameydan (HUI 17985) showed hairy glumes and rachis which is in accordance with Tzvelev (1976) who took the densely short pilose spikelets and rachis variant to describe his new variety (var. *prokhanovii*) (see Figures 2B, 2D, 2E). Plants of this accession were characterized by brownish spikes and rachis (Table 2).

According to the results of this study, despite the prevalence of hybridization in Poaceae (even inter-generic); from which natural and artificial hybrids between *A. cylindrica* and *T. aestivum* are well known and documented (Morrison *et al.*, 2002 and our unpublished data); taxonomic identity of infra-specific taxa of *A. cylindrica* could be conserved in the sympatric

localities; e.g., var. *prokhanovii* and var. *cylindrica* grow side by side but still distinct in Yasouj to Babameydan site.

Based on the results of this study we concluded that *A. cylindrica* grows in Iran with three varieties: *cylindrica*, *prokhanovii* and *rumelica*. A taxonomic key to these varieties was constructed and presented as below:

Key to the varieties of *A. cylindrica* in Iran

- 1- Awns of the uppermost spikelet longer than the total length of spike; spike usually with 3-5 spikelets var. *rumelica*
- Awns of the uppermost spikelet shorter than the total length of spike; spike with more spikelets 2
- 2- Spikelets and rachis densely and brownish pilose var. *prokhanovii*
- Spikelets and rachis scabrid, spikes green var. *cylindrica*

Acknowledgments

The authors wish to thank the Office of Graduate Studies of the University of Isfahan for their support. We are also thankful to Dr. Ernst Vitek, Dr. Lia Pignotti, Dr. Robert Vogt and their colleagues in W and B herbaria respectively. Also, we are grateful to Dr. Vello Jaaska, Dr. Bernd R. Frieb and Dr. Van Slageren for their valuable guidance and Ms. Hajian for her precise hand drawing.

References

- Arzani, A., Khalighi, M. R., Shiran, B. and Kharazian, N. (2005) Evaluation of diversity in wild relatives of wheat. *Czech Journal of Genetics and Plant Breeding* 41: 112-117.
- Bor, N. L. (1970) *Aegilops* L. In: *Flora Iranica* (Ed. Rechinger, K. H.) vol. 70. Akademische Druck-Verlagsanstalt, Graz.
- Bordbar, F., Rahiminejad, M. R., Saeidi, H. and Blattner, F. R. (2011) Phylogeny and genetic diversity of D-genome species of *Aegilops* and *Triticum* (Triticeae, Poaceae) from Iran based on microsatellites, ITS, and trnL-F. *Plant Systematics and Evolution* 291: 117-131.
- Guadagnuolo, R., Savova-Bianchi, D. and Felber, F. (2001) Gene flow from wheat (*Triticum aestivum* L.) to jointed goatgrass (*Aegilops cylindrica* Host), as revealed by RAPD and microsatellite markers. *Theoretical and Applied Genetics* 103:1-8.
- Jaaska, V. (1978) Electrophoretic study of phosphatase isoenzyme in the grass genus *Aegilops* L. *Biochemie und Physiologie der Pflanzen* 172: 133-153.
- Jaaska, V. (1981) Aspartat aminotransferase and dehydrogenase isoenzyme: intraspecific differentiation in *Aegilops tauschii* and the origin of the D genome polyploids in the wheat group. *Plant Systematics and Evolution* 137: 259-273.
- Karataglis, S. S. (1989) *Aegilops cylindrica* var. *kastorianum* (Poaceae): A new variety from Greece. *Plant Systematics and Evolution* 163: 13-20.
- Keshavarzi, M., Rahiminejad, M. R. and Kheradmandnia, M. (2007) Discriminative analysis of 10 species of *Aegilops* L. (Poaceae) native to Iran. *Iranian Journal of Science and Technology* 31(A3): 321-324.
- Kharazian, N. (2007) The taxonomy and variation of leaf anatomical characters in the Genus *Aegilops* L. (Poaceae) in Iran. *Turkish Journal of Botany* 31: 1-9.
- Kharazian, N. (2008) Chemotaxonomic studies on *Aegilops* L. (Poaceae) in Iran. *Pakistan Journal of Biological Science* 11: 1204-1211.

- Linc, G., Frieb, B. R. and Kynast, R. G. (1999) Molecular cytogenetic analysis of *Aegilops cylindrica* Host. Genome 42: 497-503.
- Morrison, L. A., Lyzarazu, O. R. and Smith, C. A. M. (2002) Jointed goatgrass (*Aegilops cylindrica* Host) × wheat (*Triticum aestivum* L.) hybrid: Hybridization dynamics in Oregon wheat fields. Crop Science 42: 1863-1872.
- Slageren, M. V. (1994) Wild wheats. A Monograph of *Aegilops* L. and *Amblyopyrum* (Jaub & Spach) Eig (Poaceae). Agricultural university, Wageningen, the Netherlands.
- Tzvelev, N. N. (1976) Grasses of the Soviet Union, Part 1. Nauka Publisher, Leningrad, Soviet Union.
- Velenovsky, J. (1891) Flora Bulgarica. Prostat Apud Fr. Rivnac, Bibliopolam, Praga.

یادداشت‌هایی بر *Aegilops cylindrica* (Triticeae, Poaceae) در ایران

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چکیده

تحقیق حاضر مبتنی بر مطالعه تاکسونومی ۱۰۰ نمونه جمعیتی از گونه *Aegilops cylindrica* جمع‌آوری شده از سرتاسر کشور و همچنین مطالعه نمونه‌های تیپ و نمونه‌های مربوط موجود در هر بار یوم‌های موزه تاریخ طبیعی وین و برلین است. نتایج این مطالعه نشان داد که صفات ریخت‌شناختی نظیر: طول سنبله، طول سیخک، تعداد سنبلک‌ها در هر سنبله، حضور/غیبت گُرک روی سنبلک‌ها و محور در بین نمونه‌های جمعیتی مطالعه شده تنوع بالایی دارد. بر اساس نتایج پژوهش حاضر، گونه *A. cylindrica* در ایران با سه وارسته که همگی گزارش جدید برای ایران هستند، شناخته می‌شود.

واژه‌های کلیدی: *Aegilops cylindrica*, Triticeae, Poaceae، تاکسونومی، ایران