

<http://www.pjbs.org>

PJBS

ISSN 1028-8880

**Pakistan
Journal of Biological Sciences**

ANSI*net*

Asian Network for Scientific Information
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan

Systematic Study of Weedy Species of *Setaria* (L.) P. Beauv. (Poaceae) in Iran

Maryam Keshavarzi and Mahvash Seifali

Department of Biology, Faculty of Science, Alzahra University, Vanak, Tehran, Iran

Abstract: Weedy species of *Setaria* (L.) P. Beauv. (Poaceae, Panicoideae and Paniceae) compose one of the worst weed groups interfering with world agriculture and in other disturbed and managed habitats. These weed species (*S. glauca*, *S. viridis* and *S. verticillata*) form the foxtail species-group in Iran. In this study 30 populations from different part of Iran were collected. Morphological traits were studied. Some morphological characters as texture of upper lemma, awn color and ligule shape are used to differentiate *Setaria* species group in Iran. It is believed that these morphological traits have a lot of overlapping. Morphological variations were evaluated by multivariate statistical methods. This study shows the systematic value of different quantitative and qualitative characters in weedy *Setaria* species native to Iran. An identification key based on studied characters is provided.

Key words: *Setaria*, Iran, foxtail, cluster analysis

INTRODUCTION

Setaria (L.) P. Beauv. (Poaceae, Panicoideae, Paniceae) comprises 125 species and some subsections in tropical regions of the world. There are four species of this genus in Iran (Bor, 1970). Many species of *Setaria* are important forage and weeds. The only world wide cultivated cereal of this genus is *S. italica* (L.) P. Beauv. Species as *S. palmifolia* Koenig is an ornamental garden species in South America (Dekker, 2003).

Inflorescence features provide good diagnostic characters in different groups of grasses which are efficient in species and sub species levels (Keshavarzi *et al.*, 2002, 2005a, b, 2007). In *Setaria* texture of upper lemma, awn color, ligule shape and etc. are used for differentiating taxa (Davis, 1965; Clayton, 1980; Bor, 1968 and 1970). Morphological used characters are some how overlapping in specific and intra-specific levels.

Setaria species in Iran have some differences in their anatomical structures. These are of diagnostic value (Keshavarzi and Seifali, 2005a). *S. viridis* shows a great variation in plant color. These are sometimes referred as different varieties (Alex *et al.*, 1972). Isoenzyme studies show that these varieties are basically identical (Dekker, 2003).

In this study we make a vast field trips and gathered many accessions of *Setaria*. Diagnostic features for differentiating the weedy species (Non- cultivated) of this genus in Iran were revised. Characters were studied biometrically. The aim of this study was to prepare an efficient identification key for this genus in Iran.

MATERIALS AND METHODS

Thirty populations of three species of *Setaria* native to Iran, were studied from 2004-2005 for their morphological diversity. Details of localities and the voucher are presented in Table 1. Voucher specimens are deposited at Herbarium of Alzahra University (Tehran, Iran).

In total 20 qualitative and quantitative morphological characters were studied (Table 2). The variables were standardized for multivariate statistical analysis. In order to group the populations with morphological similarities, cluster analysis using UPGMA (un-weighted group with arithmetic mean) and WARD (minimum variance spherical clusters) as well as ordination based on Principal Component Analysis (PCA) were performed. The squared Euclidean distance was used as the dissimilarity coefficient in a cluster analysis of morphological data.

In order to determine the most variable morphological characters among the populations, factor analysis based on Principal Component Analysis (PCA) was performed. Statistical analyses were performed by using SPSS (Ver. 9).

RESULTS

Field studies show that in disturbed and managed area in Iran, this weedy genus has more than one species. More often *S. viridis* is accompanied by one of other two species in such places. This evidence is in accordance with Dekker (2003). These species are mainly differentiated from each other by spikelets fine features in many literatures (Bor, 1968, 1970; Davis, 1965).

Table 1: Population locality and voucher details of studied *Setaria*

Species	Herb. No.	Address	Collector
<i>S. viridis</i>	832	Tehran to Chalous, Dizin.	Dehshiri
	28	Azerbaijan, Ahar.	Rismani
	33	Tehran, Nazarabad Near Karaj.	Khazaii
	34	Tehran, Sorkhe Hesar.	Sarbazi
	35	Lorestan, Khoramabad.	Deg
	21	Mazenderan, Boboul, Gadrous.	Malekshahi
	19	Semnan, Damghan.	Mohtashami
	18	Hamadan, Malayer.	Mirshahvalad
	41	Mazenderan, Ghaemshahr.	Keshavarzi
	36	Isfahan, Kashan.	Keshavarzi
	12	Fars, Shiraz.	Keshavarzi
	2	Isfahn, Natanz.	Keshavarzi
	3	Qoum, Qoum	Keshavarzi
	10	Mazenderan, Haraz.	Keshavarzi
	43	Guilan, Rasht.	Keshavarzi
	45	Guilan, Somesara.	Keshavarzi
	<i>S. verticillata</i>	4	Tehran, Tehran.
8311		Fars, Bajgah	Keshavarzi
8312		Golestan, Minodasht.	Keshavarzi
<i>S. glauca</i>	8313	Mazenderan, Noor.	Keshavarzi
	1	Mazendaran, Amol	Keshavarzi
	9	Tehran, Karaj.	Keshavarzi
	16	Isfahan, Kashan, Fin.	Keshavarzi
	17	Mazendaran, Sari.	Keshavarzi
	20	Tehran, Varamin, Parchin.	Keshavarzi
	25	Tehran, Tehran.	Keshavarzi
	29	Markazi, Delijan.	Keshavarzi
	31	Markazi, Tafresh, Dastjerd.	Keshavarzi
	32	Mazendaran, Ramsar.	Keshavarzi
	42	Mazendaran, Somesara.	Keshavarzi

Table 2: Studied qualitative and quantitative characters of *Setaria* in Iran

Character	Character
Awn color yellow 1 green 0	Length of spikelet
Glume and lemma equal 1 unequal 0	Width of spikelet
Wrinkled upper glume present 1 absent 0	Awn number of each spikelet
Upper lemma texture porate 1 without this 0	Length of inflorescence
Bristle prickles antrorse 1 retrorse 0	Maximum length of bristles
Hairs in the base of blade present 1 absent 0	Minimum length of bristles
Degree of inflorescence compactness compact 1 lobbed 0	Length of lower lemma/awn length
Hair in sheath present 1 absent 0	Length of upper lemma/awn length
Palea present 1 absent 0	Plant height
Inflorescence color green 1 yellow 0	Blade Length/blade width

Our morphological studies show that *Setaria* species native to Iran have no variation in the compactness of spike and presence of Palea. But there are great variations in awn color, the size of glume and lemma, wrinkle and texture of upper lemma, the presence of hairs in the base of leaf blade and sheath, the direction of bristle prickles and spike color.

Observations indicate that *Setaria* species native to Iran are efficiently differentiated by some studied morphological features (Table 3). *S. verticillata* (L.) P. Beauv. by a unique feature as the direction of bristle prickles (antrorse) is clearly differentiated. There are some confusion between characters of *S. verticillata* and *S. viridis* in Iran.

Variance analysis of quantitative morphological characters show that in different weedy species of *Setaria* native to Iran, leaf length to width, plant height, spike and

spikelet length, number of bristle prickles, minimum length of bristles and the length of bristles to length of lower glume have significant differences between species (Table 4). Anther length was varied from 4.5 mm. in *S. viridis* populations to 1 mm. in *S. verticillata* and *S. glauca*.

Results of quantitative morphological characters show that selected set of characters are capable of separation of *Setaria* Species in Iran. Cluster analysis and dendrograms by Ward method based on quantitative characters (Fig. 1) shows that *S. viridis* is differentiated from other two species efficiently.

In order to determine the most variable quantitative characters among studied populations, factor analysis based on PCA was performed revealing that first three factors comprise more than 92% of total variation in this genus in Iran. In the first factor with about 66% of total variation, characters such as spike length, maximum and

minimum awn length and awn number in spikelets as width of spikelet and the length to width ratio of leaf blade (Table 5) possessed the highest positive correlation. In the second factor with about 16% of total variation, characters such as width of spikelet and the length to width ratio of leaf blade (Table 5) possessed the highest positive correlation.

Table 3: Results of qualitative morphological features in *Setaria* populations native to Iran

Taxon	Herb. no.	Awn Color	Lemma and glume equality	Wrinkle in lemma	Upper lemma texture	Bristle prickle	Hairs at the base of blade	Spike compactness	Sheath hairs	Presence of palea	Spike color
<i>S. viridis</i>	3	2	2.00	2.00	1.00	1.00	1	1.00	1.00	1.00	1.00
<i>S. viridis</i>	2	2	2.00	2.00	1.00	1.00	1	1.00	2.00	1.00	1.00
<i>S. viridis</i>	4	1	1.00	2.00	1.00	1.00	1	1.00	1.00	1.00	1.00
<i>S. viridis</i>	10	1	2.00	2.00	1.00	1.00	1	1.00	1.00	1.00	1.00
<i>S. viridis</i>	43	1	1.00	2.00	1.00	1.00	1	1.00	1.00	1.00	1.00
<i>S. viridis</i>	12	1	1.00	2.00	1.00	1.00	1	1.00	1.00	1.00	1.00
<i>S. viridis</i>	18	2	1.00	2.00	1.00	1.00	1	1.00	1.00	1.00	1.00
<i>S. viridis</i>	19	1	1.00	2.00	1.00	1.00	1	1.00	1.00	1.00	1.00
<i>S. viridis</i>	21	1	1.00	2.00	1.00	1.00	1	1.00	1.00	1.00	1.00
<i>S. viridis</i>	28	1	2.00	2.00	1.00	1.00	1	1.00	1.00	1.00	1.00
<i>S. viridis</i>	33	1	1.00	2.00	1.00	1.00	1	1.00	1.00	1.00	1.00
<i>S. viridis</i>	34	1	1.00	2.00	1.00	1.00	1	1.00	1.00	1.00	1.00
<i>S. viridis</i>	35	1	1.00	2.00	1.00	1.00	1	1.00	1.00	1.00	1.00
<i>S. viridis</i>	36	1	2.00	2.00	1.00	1.00	1	1.00	1.00	1.00	1.00
<i>S. viridis</i>	41	1	2.00	2.00	1.00	1.00	1	1.00	1.00	1.00	1.00
<i>S. viridis</i>	45	2	2.00	2.00	1.00	1.00	1	1.00	1.00	1.00	1.00
<i>S. viridis</i>	832	2	2.00	2.00	1.00	1.00	1	1.00	1.00	1.00	1.00
<i>S. verticillata</i>	8313	2	1.00	2.00	1.00	2.00	2	1.00	1.00	1.00	2.00
<i>S. verticillata</i>	8311	2	1.00	2.00	1.00	2.00	2	1.00	1.00	1.00	1.00
<i>S. verticillata</i>	8312	2	1.00	2.00	1.00	2.00	2	1.00	1.00	1.00	2.00
<i>S. glauca</i>	1	1	1.00	1.00	2.00	1.00	2	1.00	2.00	1.00	2.00
<i>S. glauca</i>	9	1	2.00	1.00	2.00	1.00	1	1.00	2.00	1.00	2.00
<i>S. glauca</i>	25	1	2.00	1.00	2.00	1.00	2	1.00	2.00	1.00	2.00
<i>S. glauca</i>	20	1	2.00	1.00	2.00	1.00	1	1.00	1.00	1.00	2.00
<i>S. glauca</i>	42	1	2.00	1.00	2.00	1.00	2	1.00	2.00	1.00	2.00
<i>S. glauca</i>	29	1	2.00	1.00	2.00	1.00	2	1.00	2.00	1.00	2.00
<i>S. glauca</i>	31	1	2.00	1.00	2.00	1.00	1	1.00	2.00	1.00	2.00
<i>S. glauca</i>	32	1	2.00	1.00	2.00	1.00	1	1.00	2.00	1.00	2.00
<i>S. glauca</i>	17	1	2.00	1.00	2.00	1.00	1	1.00	2.00	1.00	2.00
<i>S. glauca</i>	16	1	2.00	1.00	2.00	1.00	1	1.00	2.00	1.00	2.00

Table 4: Descriptive statistical quantitative morphological data in weedy *Setaria* species of Iran

Character	Taxon	Average	Standard deviation	Min.	Max.	Sig.
Length to width ratio of leaf blade	<i>S. verticillata</i>	42.5	1.26	41.7	44	
	<i>S. glauca</i>	25.5	6.38	13.3	37.5	**
	<i>S. viridis</i>	14.4	3.91	7.5	20	
Length	<i>S. verticillata</i>	72.7	8.74	63	80	
	<i>S. glauca</i>	34.9	10	16	51	**
	<i>S. viridis</i>	295.9	102.5	120	510	
Spike length	<i>S. verticillata</i>	55.7	5.13	50	60	ns
	<i>S. glauca</i>	47.2	23	10	90	
	<i>S. viridis</i>	32.3	6.63	18.8	45	
Width of spikelet	<i>S. verticillata</i>	4.83	0.29	4.5	5	ns
	<i>S. glauca</i>	5.55	0.96	5	8	
	<i>S. viridis</i>	5.53	1.08	4	8	
Length of spikelet	<i>S. verticillata</i>	2	0	2	2	
	<i>S. glauca</i>	2.95	0.28	2.5	3.5	
	<i>S. viridis</i>	2	0	2	2	
Awn number per spikelet	<i>S. verticillata</i>	3.33	0.57	3	4	**
	<i>S. glauca</i>	9.75	0.63	8	10	
	<i>S. viridis</i>	5.59	3.24	2	12	
Nerve number of lower glume	<i>S. verticillata</i>	3	0	3	3	-
	<i>S. glauca</i>	3	0	3	3	
	<i>S. viridis</i>	3	0	3	3	
Nerve number of upper glume	<i>S. verticillata</i>	5	0	5	5	-
	<i>S. glauca</i>	5	0	5	5	
	<i>S. viridis</i>	5	0	5	5	
Lower glume length to awn length	<i>S. verticillata</i>	0.08	0	0.08	0.08	**
	<i>S. glauca</i>	0.16	0.02	0.13	0.22	
	<i>S. viridis</i>	0.25	0.06	0.14	0.34	

Table 4: Continued

Character	Taxon	Average	Standard deviation	Min.	Max.	Sig.
Upper Glume length to awn length	<i>S. verticillata</i>	0.28	0.05	0.25	0.33	ns
	<i>S. glauca</i>	0.31	0.04	0.25	0.33	
	<i>S. viridis</i>	1.22	1.77	0.43	8	
Max. Awn length	<i>S. verticillata</i>	6.3	0.58	6	7	ns
	<i>S. glauca</i>	7	1.05	6	9	
	<i>S. viridis</i>	6.82	1.98	4	12	
Min. Awn length	<i>S. verticillata</i>	4.67	0.58	4	5	*
	<i>S. glauca</i>	4.3	1.06	3	6	
	<i>S. viridis</i>	3.16	1.07	2	6	

ns = Non-Significant, * Significant in 5%, ** significant in 1%

Table 5: Principal component analysis of morphological characters in setaria population of Iran

Character	Component	
	1	2
Spike Length	0.935	
Maximum Awn Length	0.887	
Minimum Awn Length	0.816	
Width of Spikelet		0.921
Length to Width ratio of Leaf Blade		0.646

DISCUSSION

Observing qualitative morphological features in weedy *Setaria* populations of Iran, it seems that leaf features especially the leaf base hairs, sheath hairs and ligule shape are capable of making an efficient separation. In the other hand some species as *S. glauca* are very distinct from others by wrinkled upper lemma. Some confusion is evident in *S. verticillata* and *S. viridis* which, due to the documented cases of Flora of Iraq, could be due to the hybridization between these two species. Certainly further studies are necessary to define the hybrids. We should evaluate the characters again and especially field observation is a necessity.

Due to results of quantitative and qualitative morphological characters in studied accessions of *Setaria* in Iran, the cluster analysis was done. The dendrograms are shown in Fig. 1 and 2. Cluster of quantitative analysis show that accessions of *S. verticillata* are grouped inside a cluster of *S. glauca* but Ward dendrograms of qualitative characters dose not show such thing. After merging these two kinds of features, we found that cluster of *S. verticillata* is clearly separated from other two species. So it is apparent that quantitative features are not good choice to be used alone for *Setaria* species differentiation in Iran. We should not rely on identification key mainly based on quantitative features in *Setaria*.

In Fig. 1 it is prominent that *S. viridis* comprise a unique cluster and no other grouping is shown. In the other hand *S. glauca* show a kind of grouping. One group comprises accessions of northern and southern Alborz Mountains and the other comprises mainly populations of Central Platue of Iran. Central part of Iran contains dry, desertified low lands, salty deserts and sand dunes.

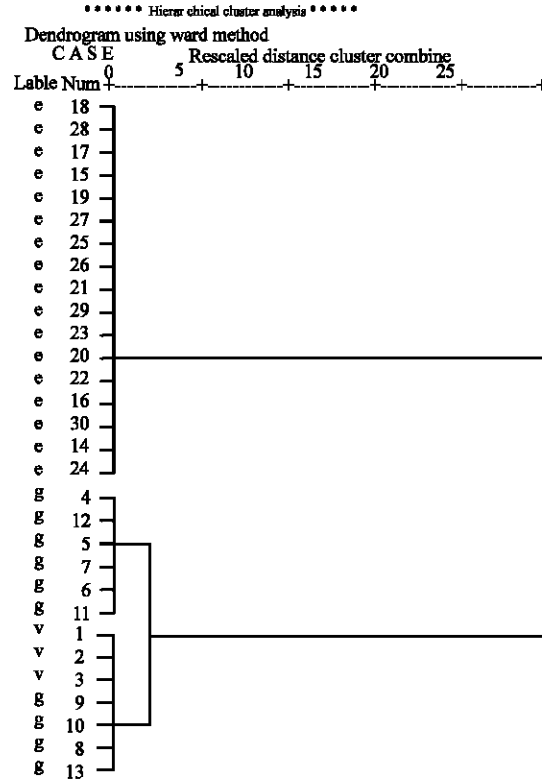


Fig. 1: Ward cluster analysis of quantitative characters in setaria species (e = *S. viridis*, g = *S. glauca* and v = *S. verticillata*)

Studying the Ward dendrogram, we found that selected set of qualitative characters in this genus is capable of a fine separation and are diagnostic. In this genus two clusters are separated. *Setaria glauca* is located in one separate cluster. In *S. glauca* two groups are defined which have different status of hairs in base of leaf blade. This grouping is not in congruence with the grouping based on qualitative characters. Separated cluster are not limited to definite geographical regions of Iran.

Other two weedy species are grouped in another cluster. In this cluster *S. verticillata* comprises a separate position in which two populations of North of Iran (Noor

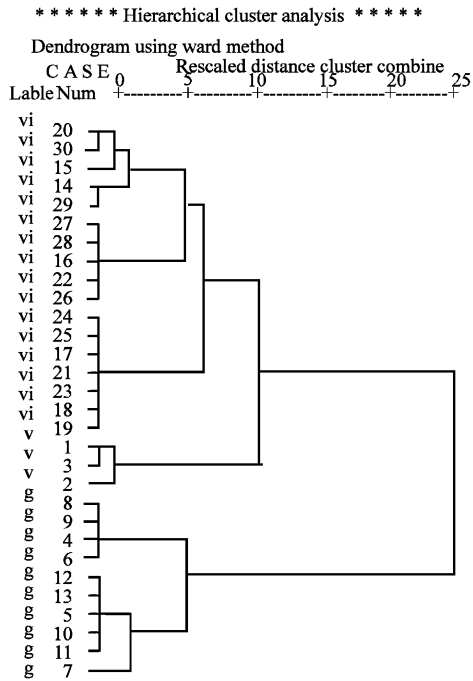


Fig. 2: Ward Cluster analysis of Qualitative Morphological features of Setaria in Iran. (vi stands for *S. viridis*, v for *S. verticillata* and g= *S. glauca*)

and Minodasht) are showing a close relationship and the population of South of Iran (Bajgah, Fars) make a separate neighboring cluster. In clusters of *S. viridis* again there is no geographical base for grouping. Dendrogram topology reveals the complete separation of these three species in Iran. After merging qualitative and quantitative characters cluster analysis result in Fig. 3. In this cluster analysis, species are clearly differentiated from each other. *S. verticillata* make a separate cluster but it shows a close position to the *S. viridis* than *S. glauca*. This final clustering dose not reflects the geographical pattern of distribution of these three species in Iran.

Principal Component Analysis (PCA) shows this separate position too (Fig. 4). In this diagram *S. verticillata* comprises an almost compact group. The populations of *S. glauca* are widely scattered. Due to studied quantitative and qualitative characters in different species of *Setaria* in Iran, these are clearly differentiated from each other in PCA analysis. Anatomical studies of leaf blades provide efficient diagnostic features in weedy species of *Setaria* in Iran (Keshavarzi and Seifali, 2005a). Due to qualitative morphological characters and the results of Factor analysis an identification key for weedy species of *Setaria* in Iran is provided:

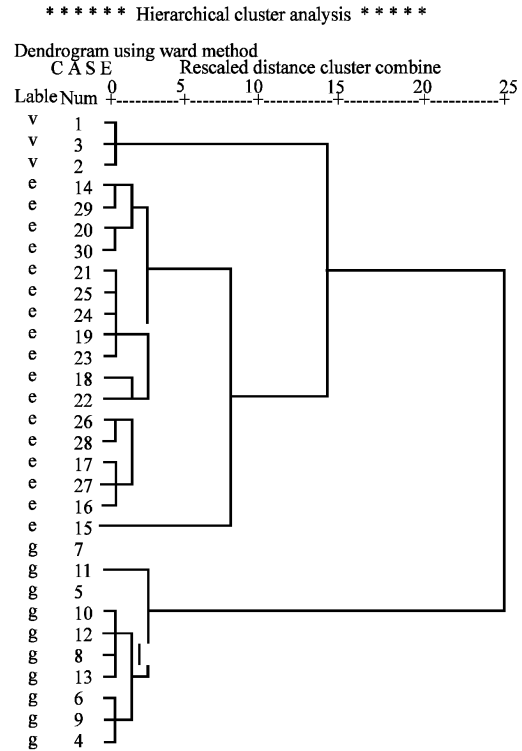


Fig. 3: Ward Cluster analysis after merging Qualitative and Quantitative Morphological features in Setaria of Iran. (e stands for *S. viridis*, v for *S. verticillata* and g = *S. glauca*)

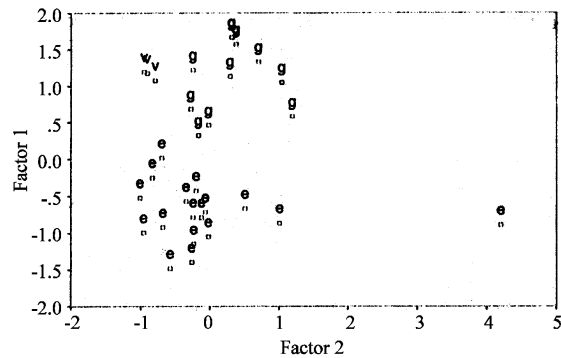


Fig. 4: PCA ordination of setaria species of Iran. (Codes as in Fig. 3)

- Spikelet length more than 2 mm, upper lemma wrinkled, upper glume shorter than upper lemma *S. glauca*
- Spikelet length less than 2 mm, upper lemma not wrinkled, glume and lemma in same length
- Bristle prickles exclusively retrorse *S. verticillata*
- Bristle prickles exclusively antrorse *S. viridis*

This study shows the efficiency of morphological features and their diagnostic value in weedy *Setaria* species native to Iran.

REFERENCES

- Alex, J.F., J.D. Banting and J.P. Gebhardt, 1972. Distribution of *Setaria viridis* in western Canada. *Can. J. Plant Sci.*, 52: 129-138.
- Bor, N. L., 1968. Gramineae. In: Townsend, C.C., E. Guest and A. Al-Rawi (Eds.), *Flora of Iraq*, 9: 172-195. Iraq Ministry of Agriculture, Baghdad.
- Bor, N.L., 1970. Gramineae. In: Rechinger, K.H. (Ed.) *Flora Iranica*. 70:191-202. Graz, Austria: Akademische Druk - Und Verlagsanstalt. Wiena.
- Clayton, W.D., 1980. *Setaria*. In: *Flora Europea*, Tutin, T.G., V.H. Heywood, N.A. Burges, D.M. Moore, D.H. Valentine, S.M. Walters and D.A. Webb (Eds.), Vol. 1, Cambridge University Press. Cambridge, U.K. pp: 263-264.
- Davis, P.H., 1965. Gramineae. In: Davis, P.H. (Ed.), *Flora of Turkey and the East Aegean Islands*, 1: 233-245. Edinburgh University Press, Edinburgh.
- Dekker, J., 2003. The evolutionary biology of the foxtail (*Setaria*) species-group. In: *Principles and Practices in Weed Management: Weed Biology and Management*; Inderjit (Ed.), Kluwer Academic Publishers, The Netherlands.
- Keshavarzi, M., M.R. Rahiminejad and M. Kheradmandnia, 2002. Morphological and anatomical variation of *Aegilops triuncialis* L. in Iran. *Pajohesh and Sazandegi J.*, 55: 14-20.
- Keshavarzi, M. and M. Seifali, 2005a. Value of anatomical structures of dorsal epidermis of *Setaria* (Poaceae) in Iran. *Sci. Technol. J. (Mohagheghe Ardebili)*, 1-10.
- Keshavarzi, M. and M.R. Rahiminejad, 2005b. Biosystematics study of *Aegilops cylindrica* Host. In Iran. (In Persian). *Alzahra Univ. J. Sci.*, 18: 41-51.
- Keshavarzi, M., M. Seifali and Kh. Babaii, 2007. A Morphological and Anatomical Study of an annual grass *Eremopyrum* (Poaceae) in Iran. *Pak. J. Biol. Sci.*, 10: 32-40.