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Morphological Variations of genus *Polypogon* in Iran

M. Keshavarzi*, F. Akhavan Kharazian & M. Seifali

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

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ABSTRACT

Polypogon (Poaceae), a Mediterranean - Southwest Asian genus with about 18 species in world and 4 species in Iran is a common adventive genus of open habitats. These halophytic or glycophytic species grow in moist areas of different habitats of Iran. These species grow in Irano-Turanian and Saharo-Sindian regions in Iran. In this study, accessions of *Polypogon* were collected from its distribution regions in Iran. There are difficulties in recognition of some *Polypogon* species by traditional identification keys. Biometrical analysis was done using 46 quantitative and qualitative morphological characters from which 13 characters were of diagnostic values. Characters such as glume apex, hairs frequency and shape, spike compactness and ligule shape were main diagnostic features of this genus in Iran. An identification key based on evaluated characters by factor analysis and principle component analysis was provided and species affinities were evaluated.

Key words: Iran, morphology, *Polypogon*, variation.

Correspondence to: M. Keshavarzi, Neshat112000@yahoo.com

چکیده

Polypogon از تیره غلات عنصری مدیترانه ای – غرب آسیایی است که در دنیا ۱۸ گونه دارد و در ایران با ۴ گونه علف هرز شناخته می شوند. این گیاه در زیستگاه‌های باز به صورت مهاجم حضور دارد. گونه های مختلف این گیاهان در زمینهای مرطوب زیستگاه‌های مختلف ایران به صورت شوره پسند یا غیر شوره پسند یافت می شوند. این گیاهان که در ایران عناصری سند و سودانی و ایرانوتورانی محسوب می شوند، علفهای هرز معروفی هستند (خصوصا دو گونه *P. monspeliensis* و *P. viridis*) . در این پژوهش برای اولین بار در ایران *Polypogon* مورد بررسی سیستماتیکی قرار می گیرد. واحدهای جمعیتی *Polypogon* از نواحی مختلف پراکنش آنها در ایران جمع آوری شدند. دشواری‌هایی در تشخیص برخی گونه های این جنس در ایران با کلیدهای شناسایی سنتی وجود دارد. تجزیه و تحلیل بیومتری ۴۶ صفت کمی و کیفی ریخت شناسی انجام شد. ۱۳ صفت دارای ارزش افتراقی شناخته شدند. صفاتی مانند وضعیت راس پوشه، فراوانی و شکل کرکها، تراکم سنبله و شکل زبانک، صفات افتراقی عمده در تشخیص گونه های این جنس در ایران محسوب می شوند. کلید شناسایی بر اساس صفات ارزیابی شده توسط تجزیه به عاملها و تجزیه به مولفه های اصلی ارائه شده است. روابط میان گونه ها ارزیابی شده است.

کلمات کلیدی: پلی پوگون، ریخت شناسی، تنوع، ایران.

INTRODUCTION

Polypogon Desf. (Poaceae, Aveneae) comprises 18 species in the world from which four species have been presented in Iran (Bor 1970). Many species of *polypogon* are important forage and weeds. *Polypogon* is the weed of different crops in Iran. Inflorescence features provide good diagnostic characters in different groups of grasses which are efficient in species and infra-specific levels (Keshavarzi *et al.* 2002 & 2007, Keshavarzi & Rahiminejad 2005, Keshavarzi & Seifali, 2005). In *Polypogon,* the glume features as awn position, hairs at glume margins are used for distinguishing taxa (Davis, 1965; Bor, 1968 & 1970). Morphological characters used are somehow overlapping in specific levels. There are confusions between taxa belonging to this genus in Iran. Distinguishing between *P. fugax* and *P. monspeliensis* is one of major difficulties in this group. *Agrostis stolonifera* hybrids with three species of *Polypogon*, rabbitsfoot-grass or beardgrass (Barkworth 2004). *P. monspeliensis* is a mostly European species

naturalized in many countries worldwide which occurs in wet-moist habitats to abandoned arable fields (Barkworth 2004). This species is one of the most troublesome weeds in many cultivation.

In this study, the morphological variations in *Polypogon* weeds species native to Iran were evaluated. Some of these species are capable to remediate soils which are polluted by plumb and selenium. Diagnostic features for distinguishing between the species of this genus were revised. Characters were studied biometrically. The aim of this study was to prepare an efficient identification key for members of this genus in Iran.

MATERIALS AND METHODS

In this study, many field trips were made to collect accessions of *Polypogon* from 2005 to 2007. Voucher details are shown in table 1. Specimens were deposited in Alzahra Herbarium. Fourteen Populations of four species of *Polypogon* native to Iran were studied for their morphological diversity. From each population, 10 individuals were studied.

In general, 46 qualitative and quantitative morphological characters were studied biometrically for 14 accessions (Tables 2 & 3). Characters were chosen due to previous studies of authors, field observations and different flora (Bor 1968, 1970 and Davis 1965). 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 principle component analysis (PCA) were performed (Ingroulle, M. J. 1986).

Table 1 - Voucher details of *Polypogon* sampled in this study.(AZU stands for Herbarium of Alzahra Univ., THU for Herbarium of Tehran Univ., SBH for Herbarium of Shahid Beheshti Univ.)

Taxon	Address and no.	Col.
P.fugax Nees ex Steud.	Guilan, Ramsar, 312F, AZU	Akhavan
P.fugax Nees ex Steud.	Lorestan, Khoramabad, Kaleidar, 23553 THU	Vaisekarami
P.fugax Nees ex Steud.	Kerman, Sirjan to Bardsir, 2300m, 87010SBH	Zehzad
P.fugax Nees ex Steud.	Golestan, Golestan National Park, Yegan to Giak, 1200 m, 831373 SBU	Zehzad
P.maritimus Willd.	Khozestan, SBU	Zehzad
P.maritimus Willd.	Kerman, Bafgh, Gogher, Cheshme Sabz to Mikhsefid, THU	Ghahreman & Attar
P.monspeliensis (L.) Desf.	Guilan, Ramsar, 85312M, AZU	Akhavan
P.monspeliensis (L.) Desf.	Khuzestan, Ahvaz, AZU	-
P.monspeliensis (L.) Desf.	Karaj, Iran Khodro city, 85M, AZU	Akhavan
P.monspeliensis (L.) Desf.	Mazendaran, Chalous, 85313M,AZU	Akhavan
P.viridis (Gouan) Breistr.	Guilan, Lahijan, Hasanbokadeh, Naghinejad, 21507THU	Naghinejad
P.viridis (Gouan) Breistr.	Tehran, Tehran University Area, 851V, AZU	Akhavan
P.viridis (Gouan) Breistr.	Guilan, Rostamabad to Rasht, 853V, AZU	Akhavan
P.viridis (Gouan) Breistr.	Guilan, Rasht, 85V4, AZU	Akhavan

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

Table 2- Studied Qualitative characters in *Polypogon* species of Iran

Character	State of Character
Growth habit	Annual (0), Annual & perennial (1)
Abaxial leaf surface Adaxial leaf surface	Glabrous (0), Scabrous(1), both types (2)
Ligule shape	Acut (0), Dendate & acute & truncate (1), Obtus (2), Truncate (3), Fring (4)
Spike compactness	Contracted (0), Noncontracted (1)
Rudimentary spikelets	Absent (0), Present (1)
Shape of glume	Obovate (0), Oblong (1)
Frequency of glume hair	Dense (0), Sparse (1)
Shape of glume apex	Awned (0), Unawned (1)
Shape of glume surface	Hispide & ciliate (0) Puberulous & ciliate (1)
Glume texture	Membranous (0), non-membranous (1)
Translucate on the lower third of glume	Absent (0), Present (1)
Glume apex	Bifid (0), Slightly bifid (1), Deeply bifid (2)
Shape of lemma	Obovate (0), Elliptic (1)
Shape of lemma apex	Awned (0), Unawned (1)
Lemma texture	Membranous (0), Non-membranous (1)
Lemma apex	Truncate (0), Obtus & dendate (1) Truncae & dendate (2)
Caryopsis shape	Elliptic (0), obovate (1), rectangular (2)
Adherence of Caryopsis to Palae	Absent (0), Present (1)

Table 3- Quantitative studied characters in *Polypogon* species of Iran

Character	Character
Lower glume width	Culm length
Length of lower glume awn	Length of longest Internode
Lemma length	Blade length
Lemma width	Blade width
Length of lemma awn	Ligule length
Paela length	Spike length
Palae width	Spike width
Anther length	Spikelet length
Caryopsis length	Spikelet width
Caryopsis width	Upper glume length
Upper glume nerve no.	Upper glume width
Lower glume nerve no.	length of upper glume awn
Lemma nerve no.	Lower glume length
Palae nerve no.	Floret number

RESULTS

Our observation on collected specimens of many herbariums revealed that more often *P. fugax* is confused and mistaken with *P. monspeliensis*. These species are mainly distinguished from each other by spikelets fine features in many literatures (Davis 1965, Bor 1968, Bor 1970).

Our morphological studies showed that *Polypogon* species native to Iran have great variations in degree of spike compactness and glume features. Observations indicated that *Polypogon* species in Iran are efficiently distinguished by some studied morphological features. Results of quantitative morphological characters showed that selected set of characters are capable of separation of *Polypogon* species in Iran. Cluster analysis and dendrograms by WARD method based on quantitative characters (Figure 1) and average linkage shows that *P. monspeliensis* and *P. fugax* are formed in a sister group and their immediate relative is *P. viridis*. By the way *P. maritimus* is clearly distinct from these taxa.

Factor analysis based on PCA was performed, revealing that first four factors comprise almost 80% of total variation in this genus in Iran. In the first factor with about 37% of total variation, characters such as shape of glume apex, spike compactness, glume shape, frequency of glum hairs and ligule shape possessed the highest positive correlation. In the second factor with about 24% of total variation, characters such as presence of rudimentary spikeles at the base of inflorescence, lemma shape, shape of lemma apex and lemma texture possessed the highest positive correlations (Table 4).

Table 4 – Principle Component Analysis of morphological characters In *Polypogon* populations of Iran

Features \ Factors	1	2
Glume apex	0.97	
Frequency of glume hair	0.97	
Shape of glume	0.97	
Spike compactness	0.83	
Ligule shape	0.80	
Rudimentary spikelet		0.85
Shape of lemma		0.80
Lemma texture		0.69
Lemma apex shape		0.65

It seems that by glume features, especially the shape of glume and its apex, its hairs frequency and lemma shape, an efficient separation could be made.

Due to the results of qualitative morphological characters in studied accessions of *Polypogon* in Iran, the cluster analysis was done. In cluster analysis, species are clearly distinguished from each other. Dendrogram based on WARD method comprises two main clusters (Figure 1). In first cluster *P. viridis* is clearly separated from others. Second cluster comprises two sub-clusters. In first sub-cluster, *P. maritimus* and in second sub-cluster two other species (*P.monspeliensis* and *P. fugax*) are placed. These two latters are morphologically very similar.

Principle component analysis (PCA) shows this separate position too (Figure 2). In this diagram *P. monspeliensis* comprises an almost compact group whose characters are not widely distributed. The characters are somehow scattered in *P. fugax*. Due to the studied quantitative and qualitative characters in different species of *Polypogon* in Iran, these are clearly distinguished from each other in PCA analysis.

DISCUSSION

Study the ward dendrogram, showed that selected set of qualitative characters in this genus is capable of a fine separation and are diagnostic. Dendrogram topology reveals the complete separation of these species in Iran. UPGMA cluster was in concordance with WARD method. Due to the qualitative morphological characters and the results of factor analysis, an identification key for *Polypogon* in Iran is provided.

1a-Inflorescens a lax panicle, glumes without awn	*P.viridis*
1b-Infloresence a compressed panicle, glumes awned	2
2a- Base of spike without sterile spikelets, top of glume comprises two deep lobes, lemma awnless, glumes hairy at least at 1/3 of its length	*P.maritimus*
2b-Base of spike with sterile spikelets, top of glume some how bifid, lemma awned, Glumes non- hairy at least at 1/3 of its length	3
3a-Length of glume awn 1-2 times more than glume length, glumes oblong, membranous, hair density at base of glume low	*P. fugax*

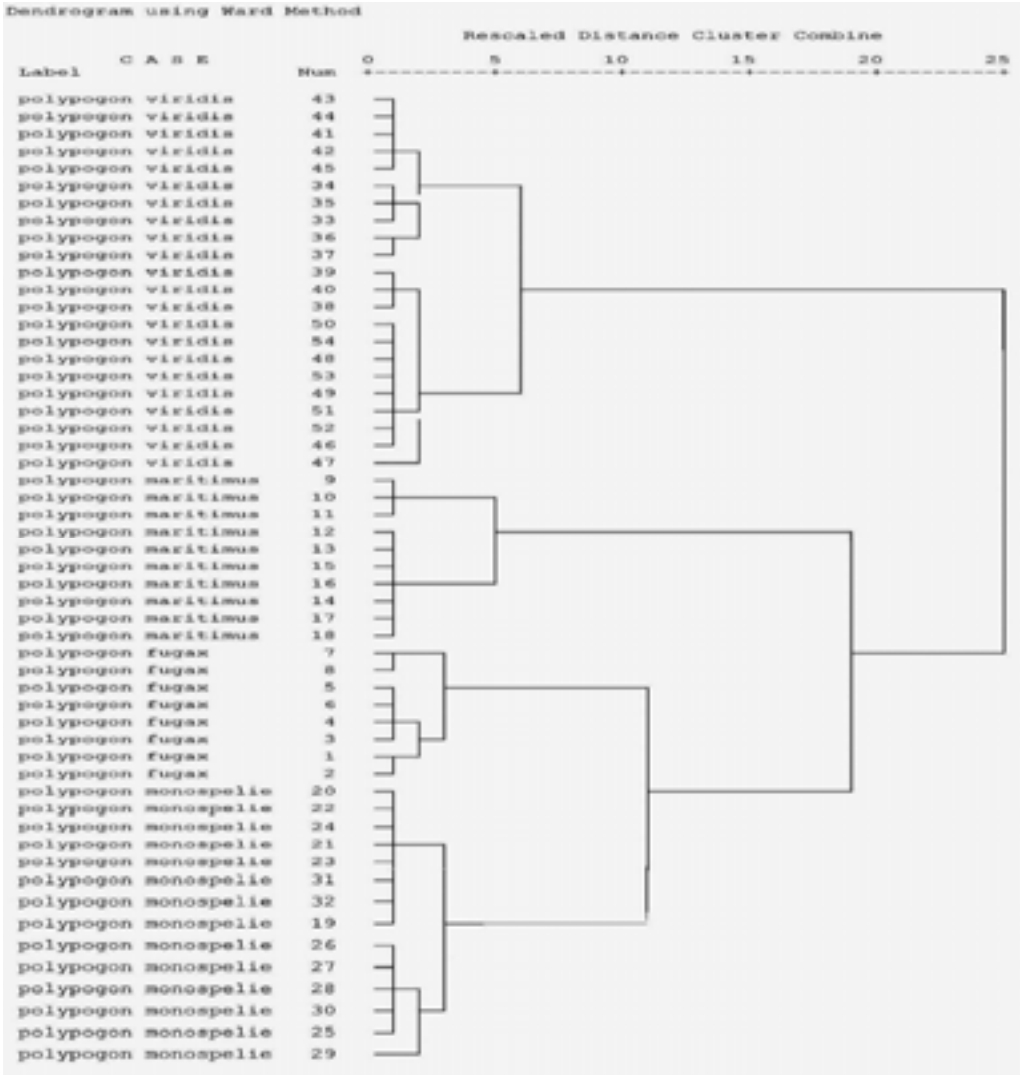

Figure 1 – Dendrogram of Quantitative Charactersin *Polypogon* species of Iran.

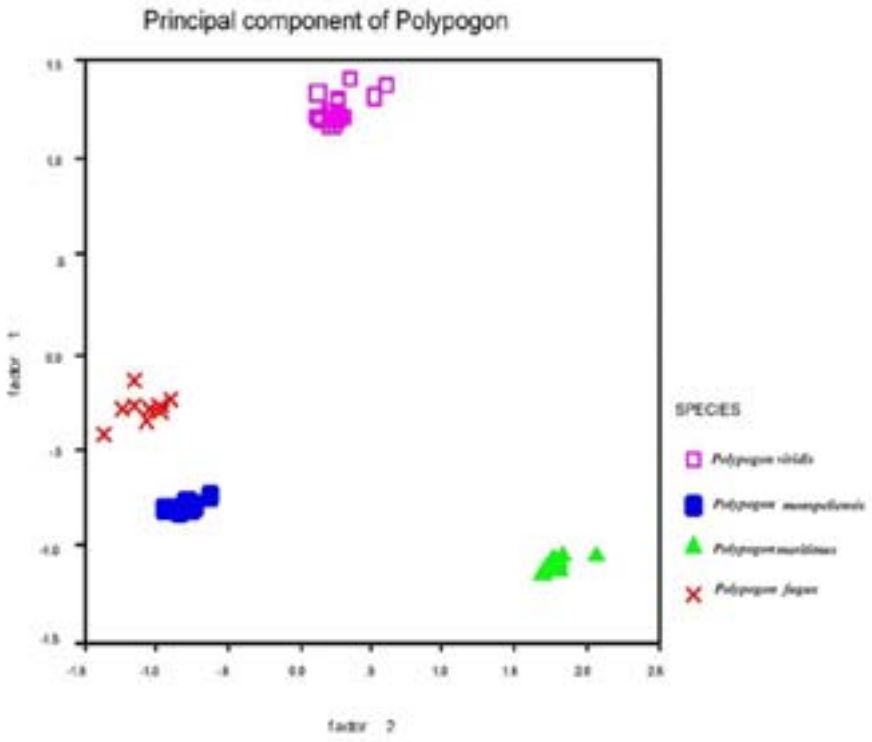

Figure 2 – PCA ordination of *Polypogon* Species of Iran.

Morphological variations of *Polypogon* species were studied. The values of characters were evaluated. Due to the observed differences, their affinities were discussed. Further study should focus the genetic variation of some taxonomic confusing species as *P. fugax* and *P. monspeliensis*.

On the basis of the results on *polypogon* of Iran, *P. monspeliensis* among the studied species was found to have the highest potential for being a weed with different shapes in the farms of Iran. Due to the documented cases, there could be some gene flow between *Polypogon* and *Agrostis*. Further studies are necessary to

define these probable hybrids. This study, as the first step in the study the *Polypogon* species of Iran, shows the efficiency of morphological features and their diagnostic value in *Polypogon* species native to Iran.

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