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Morphological Variation and Taxonomic Conclusion of *Cynodon dactylon* (L.) Pers. In Iran

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Abstract: *Cynodon dactylon* is widely distributed in Iran in diverse habitats. In this study, morphological variation of 46 populations of this species was evaluated based on 52 qualitative and quantitative characters to reveal the true taxonomic situation of the species. High morphological variation with no significant correlation with geographical and ecological conditions was observed. Among the morphological characters, presence of hair on leaf and sheath surfaces and spike color had major role on groupings in dendrogram. Based on the results of this study, presence of pilose hairs on leaf surfaces and outer surface of leaf sheath were shown to be stable diagnostic characters in detecting infraspecific taxa and accordingly, the species *C. dactylon* present in Iran two varieties: var. *dactylon* and var. *villosus* Regel. A morphological description for this species and taxonomic key of the varieties are provided.

Key words: *Cynodon dactylon*, morphology, taxonomy, variation, Iran

INTRODUCTION

Cynodon dactylon (L.) Pers. (common bermudagrass) is a perennial herb belonging to the tribe Chlorideae (Poaceae). Its role as turf grass, forage and its function in soil stabilization and conservation (Roudsari and Pishdar, 2007), protecting the soil of erosion and also its nature as weed (Oad *et al*., 2007; Mahanta *et al*., 2007) and medicinal plants (Nagori and Solanki, 2011; Chaudhary *et al*., 2001; Garg and Paliwal, 2011; Mahesh and Brahatheeswaran, 2007) made this species as an economically importance species (Bor, 1968; Assefa *et al*., 1999). Today, it is widely used as warm-season turf and forage species in the temperate and tropical regions (Li and Qu, 2004). The populations of this species harbor many useful physiological traits such as tolerance to high temperature and drought (Bethel, 2005).

This species was validated by Linnaeus (1753) as *Panicum dactylon* L. Persoon (1805) transferred it to the monotypic genus *Cynodon* Rich. as *Cynodon dactylon* (L.) Pers.. Morphological complexities resulted in different infraspecific classifications in the species. In taxonomic revision of the *Cynodon* genus published by Harlan *et al* . (1970), this species comprises six varieties include var. *dactylon*, var. *afghanicum* Harlan et de Wet, var. *aridus* Harlan et de Wet, var. *coursii* (*A. camus*) Harlan et de Wet, var. *elegans* Rendle and var. *polevansii* (Stent) Harlan et de Wet. Meanwhile, *Cynodon dactylon* var. *dactylon* is the most widely distributed and genetically variable variety in this species. Rozhevits and Shishkin (1934), Tutin *et al*. (1980) and Nasir and Ali (1982) recognized no subspecies or variety for it. Two varieties: var. *dactylon* and var. *villosus* Regel were recognized by Bor (1968) based on absence/presence of villous hairs on racemes and by Davis (1985) based on absence/presence of pilose hairs on leaf blades and/or leaf surfaces. Wu *et al*. (2006) subdivided this species into two varieties *dactylon* and *biflorus* Merino. based on having one or two bisexual floret in spikelet.

Harlan and de Wet (1969) suggested that the species is originated and diversified somewhere from West Pakistan to Turkey (i.e., Turkey, Iran, Afghanistan and the West part of Pakistan) and distributed in all countries and islands between about lat 45°N and lat 45°S and penetrates to approximately lat 53°N in Europe. Information on the genetic and cytological diversity of *C. dactylon* in its center of diversity is meager.

The taxonomic status and morphological diversity of this species in Iran is unclear. This study aimed to revise the taxonomic status of *C. dactylon* in Iran and to evaluate the morphological variation of this species and find out the taxonomic characters separating possible taxa belonging to this species in Iran.

MATERIALS AND METHODS

A total of 460 individual plants belonging to 46 populations of *C. dactylon* were specifically collected from various regions of Iran for this study (Table 1). The specimens were collected from regions with different

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Table 1: Collection site of 46 Iranian populations of *Cynodon dactylon* analysed in this study

Population code	Collection site*	Data	Herbarium code
1	C: Isfahan, University of Isfahan campus, N: 32° 36.988′, E:51°39.808′, alt: 1604 m	17/4/2009	HUI 17395
2	C: Isfahan, Dormitory of University of Isfahan, N: 32°36.988′, E: 51° 39.808′, alt: 1610 m	5/5/2009	HUI 17396
3	C: Isfahan, Kashan, Abyaneh village, N: 33°59′, E: 51°27′	6/5/2009	HUI 17397
4	C: Karaj, Peykanshahr, Botanical garden, alt: 1300 m	13/5/2009	HUI 17398
5	C: Qom, 16 km Qom toward Tehran	14/5/2009	HUI 17399
7	W: Lorestan, Azna, alt: 1880 m	3/7/2009	HUI 17401
9	W: Kermanshah, Tagh-e-Bostan, alt: 1200 m	3/7/2009	HUI 17403
10	W: Kurdestan, 15 km Kamyaran toward Kermanshah	3/7/2009	HUI 17404
11	W: Kermanshah, 60 km of Kermanshah	4/7/2009	HUI 17405
14	W: Kurdestan, Sannandaj, Abidar park, alt: 2550 m	5/7/2009	HUI 17408
15	W: Kurdestan, 10 km Sannandaj toward Hamedan	5/7/2009	HUI 17409
17	C: Markazi, Road of Malayer toward Arak, 6 km to Mohajeran, N: 34°2.764′, E: 49° 21.321′, alt: 1864 m	5/7/2009	HUI 17411
18	C: Markazi, Road of Malayer toward Arak, Bikhash village, N: 32°6.38′, E: 49°4.617′, alt: 2072 m	5/7/2009	HUI 17412
19	C: Hamedan, N: 34°55′, E: 48°21′, alt: 1934 m	5/7/2009	HUI 17413
20	W: Kurdestan, Road of Qorveh toward Hamedan, N: 34°57.947′, E: 48°8.014′, alt: 1923 m	5/7/2009	HUI 17414
21	C: Hamedan, Ganjnameh, N: 34°45.682′, E: 48°26.35′, alt: 2200 m	5/7/2009	HUI 17406
22	C: Hamedan, Azandariyan, alt: 1836 m	5/7/2009	HUI 17407
23	C: Isfahan, Khansar, Golestankooh, N: 33°36.797′, E: 49°12.574′, alt: 2670 m	6/7/2009	HUI 17410
24	N: Gilan, Roodsar, N: 37°12′, E: 50°30.24′, alt: -10 m	23/7/2009	HUI 17415
25	N: Gilan, Langarud, Soltanmoradi village, N: 37°11′, E: 50°10.30′, alt: -5 m	29/7/2009	HUI 17416
26	C: Chaharmahal-o-Bakhtiyari, Borujen, N: 31°45.956′, E: 51°10.401′, alt: 2197 m	31/7/2009	HUI 17417
28	W: Kurdestan, 45 km Divandarreh toward Sannandaj, N: 33°11.843′, E: 50°2.543′, alt: 1645 m	2/8/2009	HUI 17418
30	W: Kurdestan, 25 km Baneh toward Saqez, N: 36°10.511′, E: 46°4.298′, alt: 1520 m	3/8/2009	HUI 17419
32	W: Kurdestan, University of Payamenoor Saqez campus, alt: 1487 m	3/8/2009	HUI 17420
33	NW: Sardasht, N: 35°33.989′, E: 47°8.430′, alt: 1360 m	3/8/2009	HUI 17421
36	NW: Uromieh Lake bank, N: 38°0.436′, E: 45°5.956′ alt: 1288 m	4/8/2009	HUI 17422
37	NW: Uromieh Lake, 20 km of Tasog toward Shabestar, N: 38°18.122′, E: 45°21.356′, alt: 1367 m	4/8/2009	HUI 17423
38	NW: Ahar toward Meshkin Shahr, 20th km, Nagarehkob village, alt: 1250 m	5/8/2009	HUI 17424
39	NW: Ardabil, Saballan slopes, 8 km of Giuregeh and Moiel hot spring, alt: 1770 m	5/8/2009	HUI 17425
40	NW: Ardabil, Namin, alt: 1500 m	6/8/2009	HUI 17426
42	N: Gilan, Talesh	6/8/2009	HUI 17427
43	NW: Ardabil, 10 km of Khalkhal toward Mieyaneh, alt: 1600 m	6/8/2009	HUI 17428
44	NW: Ardabil, Givi toward Khalkhal, alt: 1463 m	6/8/2009	HUI 17429
45	NW: Miyaneh toward Zanjan, 120 km to Zanjan, alt: 1100 m	7/8/2009	HUI 17430
46	S: Hormozgan, Bandar-Abbas, alt: 0 m	16/3/2010	HUI 17431
47	S: Hormozgan, Bandar Charak, alt: 0 m	16/3/2010	HUI 17432
48	S: Bushehr, 10 km Ganaveh toward Bushehr, alt: 0 m	17/3/2010	HUI 17433
49	SW: Khuzestan, Ramhormoz toward Baghmalek, Meydavoud, alt: 415 m	19/3/2010	HUI 17434
50	SW: Khuzestan, Ramhormoz toward Baghmalek, Rood Zard, alt: 300 m	19/3/2010	HUI 17435
51	SW: Khuzestan, Shoushtar toward Ahvaz, 70th km, alt: 110 m	16/4/2010	HUI 17436
52	S: Hormozgan, Bandar-Abbas, park Dolat, alt: 0 m	17/4/2010	HUI 17437
53	E: Zahedan, alt: 1385 m	24/11/2010	HUI 17421
54	C: Yazd, alt: 1230 m	2/6/2010	HUI 17439
55	SE: Kerman, Dehbakri toward Bam, N: 29° 32.76′, E: 57°54.18′, alt: 2500 m	3/6/2010	HUI 17440
56	SE: Kerman, 15 km Baft toward Sirjan, N: 29°15.22′, E: 56°21.50′, alt: 2339 m	4/6/2010	HUI 17441
57	S: Hormozgan, Hajiabad toward Darab, N: 28°17.53′, E: 55°53.44′, alt: 2339 m	4/6/2010	HUI 17442

* C: Center, W: West, N: North, NW: Northwest, S: South, E: east, SE: Southeast and SW :Southwest.

ecological conditions. Taxonomic identifications were made based on Bor (1970). Variability of 59 qualitative and 26 quantitative morphological characters were evaluated among the specimens. Twenty-six out of 59 qualitative characters showed variability among individuals and were used for further analyses together with 26 quantitative characters (Table 2, 3). In multistate qualitative characters, each state was considered as one independent character and converted to a binary (absent/present) character. The quantitative characters were standardized using formulae:

$$X_s = \left(x - \frac{min}{max - min}\right)n$$

where, X_s is the standardized data, x is the raw data, min and max are the minimum and maximum amount of the data and n is number of observations. Data were analysed using NTSYS-pc 2.02 software (Rohlf, 1998).

Different similarity coefficients were used to calculate morphological similarities. To test the goodness of fit of a cluster analysis to our data, the cophenetic value matrix from each tree matrix was computed, which was then compared with its corresponding similarity matrix (matrix comparison) to compute the matrix correlation value (r value). The simple matching coefficient (Sneath and Sokal, 1973) based similarity matrix showed the highest r value and was used to generate dendrograms. Dendrograms were generated after cluster analysis with

Table 2: List of evaluated variable qualitative morphological characters used for diversity analysis in *Cynodon dactylon* in Iran

No.	Character	Character states
1	Stem node and internode hairs	Absent
		Present
2	Basal hairs of inflorescence	Stout
		Slender
		Short
		Long
		Dense
		Sparse
3	Hairs on inflorescence base	Sparse
		Dense
4	Position of spikes on the peduncle	Counected at base
		Not as above
5	Spike color	Green
		Glaucus
		Green with purple spots
		Pale-green
6	Leaf upper surface hairs	Absent
		Present
7	Density of hairs on Leaf upper surface	Sparse
		Dense
8	Shape of leaf upper surface hairs	Pilose
		Tomentose
9	Leaf lower surface hairs	Absent
		Present
10	Density of hairs on Leaf lower surface	Sparse
		Dense
11	Shape of leaf lower surface hairs	Pilose
		Tomentose
12	Outer surface hairs of leaf sheath	Absent
		Present
13	Hairs density on outer surface of leaf sheath	Sparse
		Dense
14	Ligule marginal ornamentations	Glabrous
		Pilose
15	Auricle	Absent
		Present
16	Spikelet color	Green
		Green with purple spots
		Pale-green
		Glaucus
17	Pedicle	Absent
		Present
18	Sterile floret	Reduced
		Developed
19	Glume color	Green
		Glaucus
		Green purplish
20	Lemma tip shape	Truncate
		Acuminate
21	Lemma color	Light green
		Green with purple spots
		Straw
		Yellow
		Violet
22	Lemma abaxial surface hairs	Absent
		Present
23	hairs of central vein on lemma	Short
		Long
		Sparse
		Dense
24	Lemma marginal ornamentations	Glabrous
		Villosus
25	Palea color	Light green
		Green purplish
		Straw
26	Stigma color	Purple
		Yellow
		Yellow-purple

Table 3: List of evaluated quantitative morphological characters in species *Cynodon dactylon*

No	Character	No	Character
1	Plant height	14	Ratio of glume to floret
2	Upper internode length	15	Lemma length
3	Inflorescence length	16	Lemma width
4	Number of rachis (inflorescent branches)	17	Number of veins on lemma
5	Spike length	18	Palea length
6	Number of rachis veins	19	Palea width
7	Spikelet length	20	Number of keel on palea
8	Spikelet width	21	Lodicule size
9	Number of spikelets per inflorescence	22	Number of lodicules
10	Upper glume length	23	Number of stamens
11	Upper glume width	24	Caryopsis length
12	Lower glume length	25	Caryopsis width
13	Lower glume width	26	Ratio of density size to caryopsis length

the unweighted pair group method using arithmetic averaging (UPGMA).

RESULTS AND DISCUSSION

Morphological diversity: Analysis of morphological data showed high variability among the populations studied. In cluster analysis, the reproductive characters had higher influence on groupings of populations in dendrogram. Status of leaf surface and abaxial sheath surface hairs were major factors separating the dendrogram main branches.

In dendrogram generated based on the qualitative characters (Fig. 1), populations were divided in two major groups with 61% similarity value (groups A and B in Fig. 1). These two groups were different mainly in status of hairs on both surfaces of leaf and outer surface of sheath and spike color. The group A comprises those populations with pale-green spikes and without pilosus hairs on abaxial leaf and sheath surfaces. Within this group, in population 45 (subgroup A_2), some individuals had pilosus hairs on abaxial leaf and sheath surfaces and was separated from others (subgroup A_1). Further subdivisions within these groups were made by present or absent of tomentose hairs on both sides of leaf and sheaths (subgroups A_1a and A_1b in Fig. 1).

Group B was subdivided into two groups based on present or absent of pilosus hairs on both sides of leaf and outer surface of sheath and violet spots on leaf surface. Populations located in subgroup B_1 lacking pilosus hairs on one of the above surfaces and had violet spots, however, the populations in subgroup B_2 had both characters together. Populations in group B_1 were divided into two subgroups based on present of sparse hairs on abaxial leaf surface and absent of it on outer sheath surface (subgroups B_1a and B_1b). Group B_2 were divided into subgroups (B_2a and B_2b). Subgroup B_2b comprises

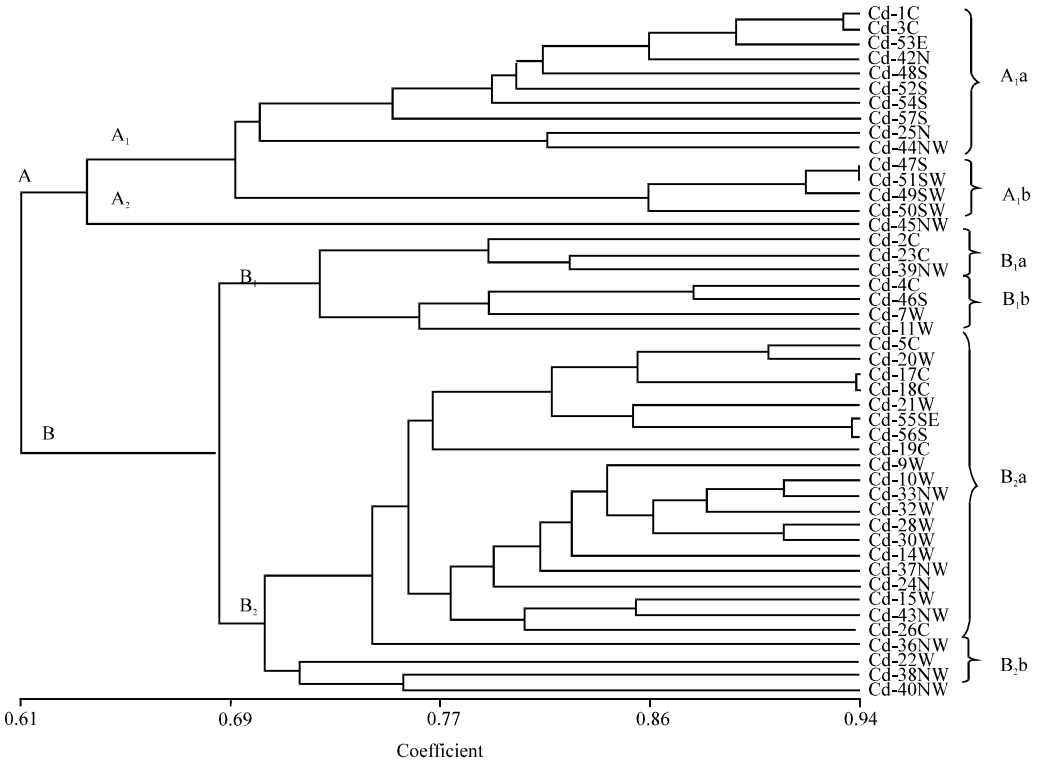

Fig. 1: UPGMA dendrogram based on 26 variable qualitative characters analysed among 46 population of *Cynodon dactylon* collected from Iran using simple matching coefficient. Population numbers are shown with geographic origin (N, NW, W, S, SE, SW, E and C, Table 1)

those populations with short pilose hairs on abaxial leaf surface and dense pilose hairs on outer sheath surface.

Hair presence on leaf and sheath surfaces were important characters analysed in many previous studies (Boissier, 1884; Rozhevits and Shishkinm, 1934; Bor, 1970; Davis, 1985). Rozhevits and Shishkin (1934) reported two forms *glabrum* Roshev. and *villosum* Rgl. within this species based on presence/absence of hairs on leaf surface. Presence or absence of hairs on leaf and sheath were used by Davis (1985) as diagnostic characters for distinguish var. *dactylon* and var. *villosus* Regel within this species.

Based on the results of this study there were no correlation between ecological conditions and presence and density of hairs. This character was diagnostic for distinguishing infraspecific taxa. Despite being highly variable, other qualitative characters showed no variation related to the infraspecific taxa.

Variability of quantitative characters was considerably lower than that of the quantitative ones. In dendrogram generated based on quantitative characters (Fig. 2), populations were divided into two groups at 53% similarity. Difference in the width of the lower glume had major role in this grouping. Group A was subdivided into two subgroups based on Inflorescent length (subgroups A_1 and A_2). Also stem length had major role in subgroup formations within group A_1 (subgroups A_1a and A_1b). The group B was subdivided into subgroups based on differences in the number of nerves on the rachis, length and width of upper and lower glumes. Dendrogram generated based on a combination of qualitative and quantitative characters (Fig. 3) showed high similarity in topology and branching with that constructed based on qualitative characters only, indicating that the diversity presented in this species is mainly due to the variation in qualitative characters.

Regarding high apomixy and outbreeding in this species, it can be suggested that different genotypes of this species colonized first in different regions and then, outbreeding distributed this genetic diversity all over the different regions. This high diversity then was established by apomixy.

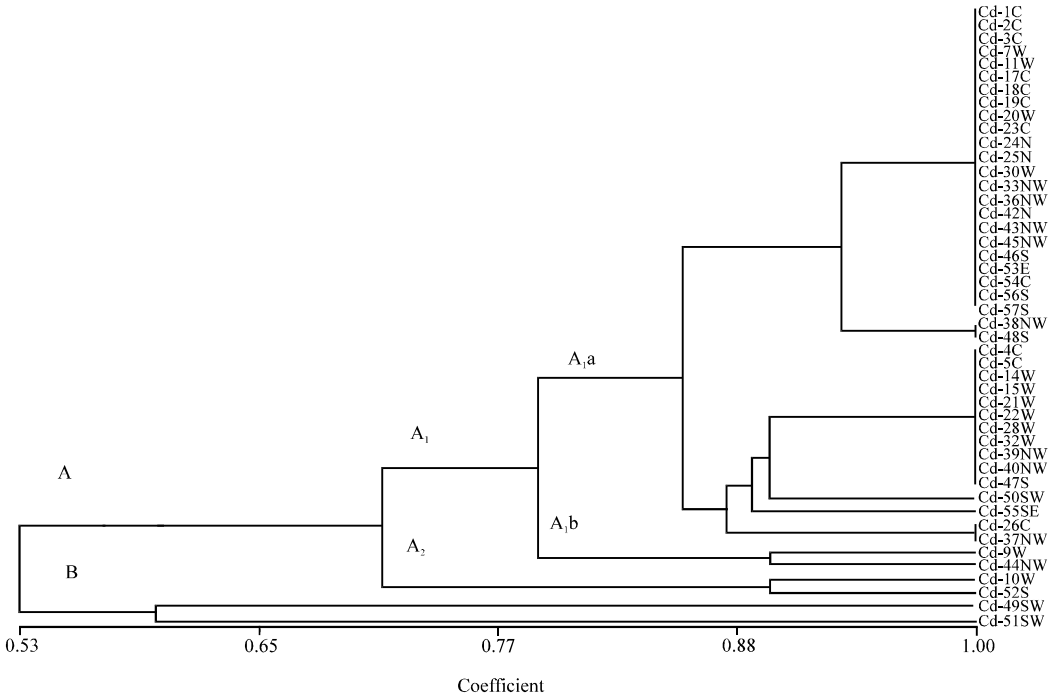

Fig. 2: UPGMA dendrogram based on 26 standardized quantitative characters examined among 46 population of *Cynodon dactylon* collected from Iran using simple matching coefficient. Population names are shown with geographic origin (N, NW, W, S, SE, SW, E and C, Table 1)

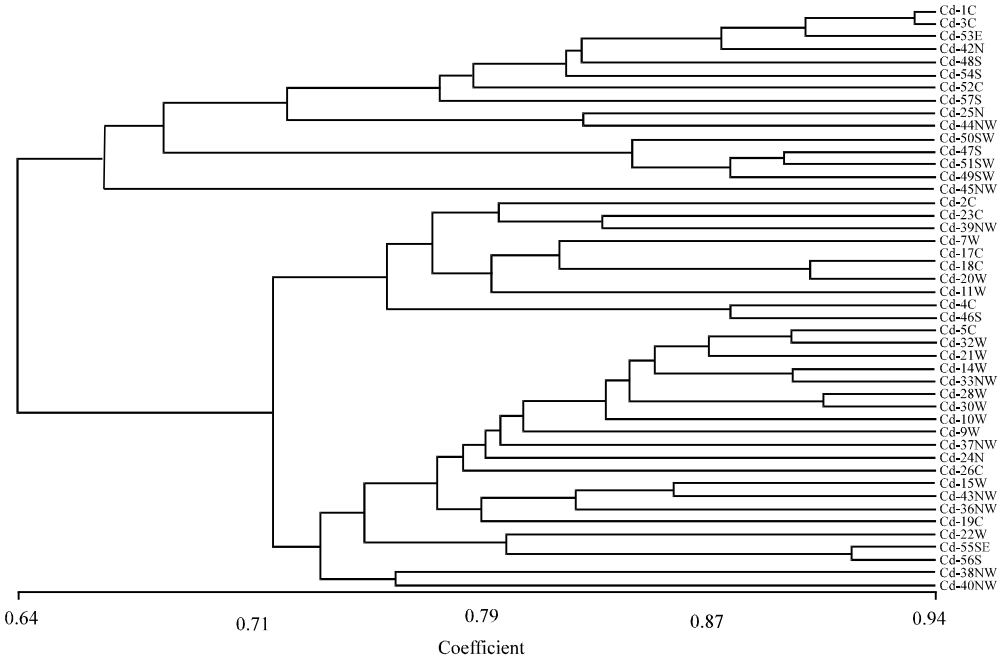

Fig. 3: UPGMA dendrogram based on 26 variable qualitative and 26 standardized quantitative characters examined among 46 population of *Cynodon dactylon* collected from Iran using simple matching coefficient. Population numbers are shown with geographic origin (N, NW, W, S, SE, E, SW and C, Table 1)

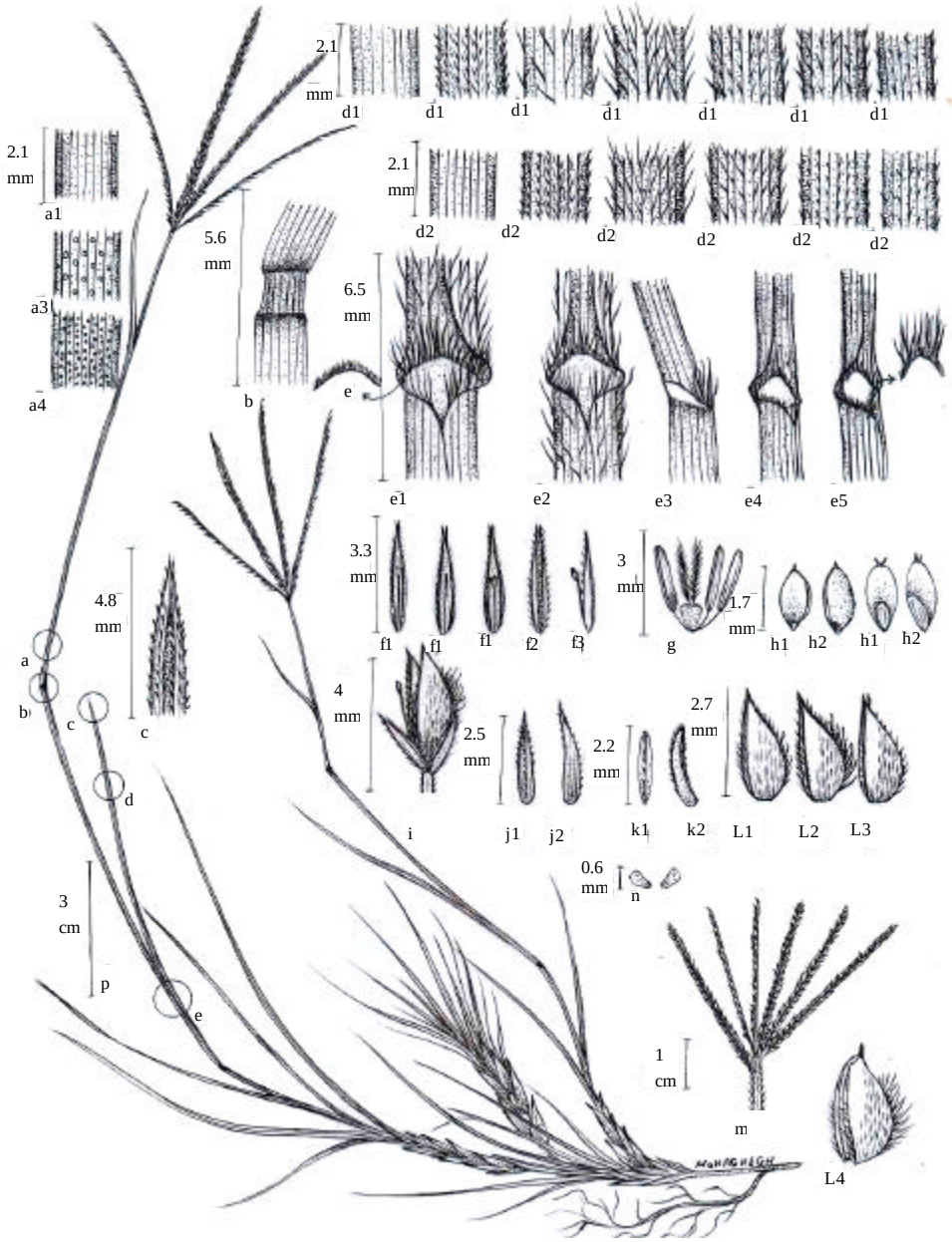

Fig. 4: *Cynodon dactylon* (L.) Pers., A: Plant habit, a_{1-4}: Stem, b: node, c: Leaf marginal ornamentations, d_1: Leaf upper surface, d_2: Leaf lower surface, e: Ligule, e_{1-5}: Leaf sheath, f_{1-3}: Palea, g: Anthers and pistil (flower), h_{1-2}: Seed, i: Spikelet, j_{1-2}: Upper glume, k_{1-2}: Lower glume, l_{1-4}: Lemma, m: Inflorescence, n: Lodicule

Taxonomy:

- *Cynodon dactylon* (L.) Pers., Syn. Pl. 1: 85 (1805)
- Syn: *Panicum dactylon* L., Sp. Pl. 58 (1753)

Herbaceous, perennial, rhizomatous and with creeping stem. Rhizomes branched, scaled, glabrous, light pink to yellowish. Creeping stem long and rooted at nods. Flowering stems many, erect, ascendant, 7-49.5 cm, usually glabrous, rarely hairy, ended to a set of spikes 2-8 cm long (Fig. 4 and 5). Leaves linear – lanceolate, flat, acute, green and scabrous at margins. Both surfaces of leaf and outer surface of sheat glabrous or with short or long hairs. Ligule a fringe of white hairs. Inflorescent

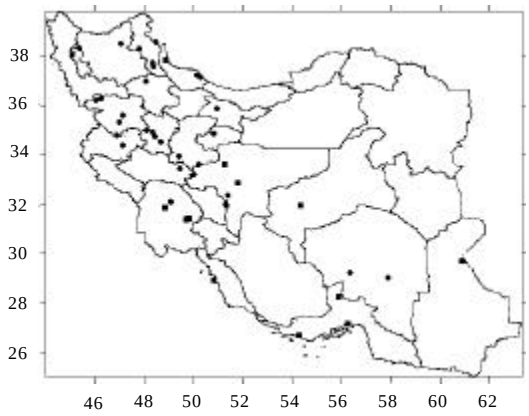

Fig. 5: Collection sites of population of species *Cynodon dactylon* (L.) Pers. in Iran. var. *villosus* Regel (•) and var. *dactylon* (■) analysed in this study

raceme-like panicle, pilosus at base and with 3-6 rarely to 9 spikes. Spikes glabrous, elongated, green to pale green, or green with purple spots, yellowish at maturity. Rachis scabrid and ribbed. Spikelet ovate, 2-3 mm, usually purplish, stalked, awnless, oriented at one side of rachis, with one fertile and one aborted florets. Glumes unequal and shorter than florets. Upper glum longer than the lower, 1.1-2.5×0.6-0.8 mm, acute, awnless, keeled, scabrous at abaxial surface of the keel, with a green rib at the keel. Lower glume membranous, 1.1-2.2×0.4-0.8 mm, keeled to falciform, glabrous, acuminate, awnless, scabrous at keel. Lemma ovate to oblong, acute to acuminate, keeled, green to pale-green, with purple spots, glabrous, with three nerves, 1.9-2.7×0.7-1.1 mm. palea linear, elongated, acuminate, with tow keels, usually with short and dense hairs at keels, 1.7-2.8×0.3-0.5 mm. Lodicules 2, membraneous, clavate. Stamens 3, yellowish to purple, with big anthers. Grain oblong, glabrous.

- Flowering time: May-June
- Distribution: cosmopolitan
- Distribution in Iran: this species distributed in different regions of Iran with a vast range of environmental conditions, from sea side to above 2700 m

Based on the results of this study, there are tow varieties of this species in Iran that can be distinguished by taxonomic key as below:

- Plant without hair .....var. *dactylon*
- Plant with hairs at least at one sides of leaf surfaces or outer surface of sheath .....var. *villosus*

REFERENCES

Assefa, S., C.M. Taliaferro, M.P. Anderson, B.G. de los Reyes and R.M. Edwards, 1999. Diversity among *Cynodon* accessions and taxa based on DNA amplification fingerprinting. Genome, 42: 465-474.

Bethel, C.M., 2005. A framework linkage map of bermudagrass (*Cynodon dactylon* x *transvaalensis*) based on single-dose restriction fragments. M.S. Thesis, University of Georgia, Georgia.

Boissier, E., 1884. Flora Orientalis. Geneva Basel, 5: 553-554.

Bor, N.L., 1968. Gramineae. In: Flora of Iraq, Townsend, C.C., E. Geust and A. AL-Rawi (Eds.). The Ministry of Agriculture of the Republic of Iraq, Baghdad, pp: 454-456.

Bor, N.L., 1970. Gramineae. In: Flora Iranica, Rechinger, K.H. (Ed.). Akademische Druck - u. Verlagsanstalt, Graz, Austria, pp: 450-452.

Chaudhary, M.I., A.S. Mumtaz and M.A. Khan, 2001. Leaf epidermal anatomy of medicinal grasses of Islamabad, Attock and Mirpur (Azad Kashmir). Pak. J. Biol. Sci., 4: 1466-1469.

Davis, P.H., 1985. Flora of Turkey and the East Aegean Islands. Edinburgh University Press, Edinburgh, UK., pp: 579-581.

Garg, V.K. and S.K. Paliwal, 2011. Anti-inflammatory activity of aqueous extract of *Cynodon dactylon*. Int. J. Pharmacol., 7: 370-375.

Harlan, J.L. and J.M.J. de Wet, 1969. Sources of variation in *Cynodon dactylon* (L.) Pers. Crop Sci., 9: 774-778.

Harlan, J.R., 1970. A Guide to the Species of *Cynodon* (Gramineae). Oklahoma State University Agricultural Experiment Station, USA., Pages: 37.

Li, L. and R. Qu, 2004. Development of highly regenerable callus lines and biolistic transformation of turf-type common bermudagrass [*Cynodon dactylon* (L.) Pers.]. Plant Cell Rep., 22: 403-407.

Linnaeus, C., 1753. Species Plantarum. Vol. 1., Bernard Quaritch, London. Pages: 58.

Mahanta, J.J., M. Chutia and T.C. Sarma, 2007. Study on weed flora and their influence on patchouli (*Pogostemon cablin* Benth.) oil and patchoulol. J. Plant Sci., 2: 96-101.

Mahesh, N. and D. Brahatheeswaran, 2007. Anti-hyperglycemic activities of aqueous and ethanolic extracts *Cynodon dactylon* (Linn) streptozotocin-induced diabetic rats. Asian J. Biochem., 2: 66-72.

Nagori, B.P. and R. Solanki, 2011. *Cynodon dactylon* (L.) Pers.: A valuable medicinal plant. Res. J. Med. Plant, 5: 508-514.

Nasir, E. and S.L. Ali, 1982. Flora of Pakistan (Poaceae). Royal botanic Gardens Kew, London, UK, Pages: 143.

Oad, F.C., M.H. Siddiqui, U.A. Buriro and G.S. Solangi, 2007. Weed management practices in cotton crop. Asian J. Plant Sci., 6: 344-348.

Persoon, C.H., 1805. Synopsis Plantarum, seu *Enchiridium botanicum*, Complectens Enumeratonem Systematicam Specierum Hucusque Cognitarum. Vol. 1, Parisiis Lutetiorum, Paris, pp: 85.

Rohlf, F., 1998. NTSYS-pc: Numerical Taxonomy and Multivariate Analysis System. Version 2.2, Exeter Publications Setauket, New York.

Roudsari, O.N. and H. Pishdar, 2007. Evaluation of Composted Sewage Sludge (CSS) as a soil amendment for bermudagrass growth. Pak. J. Biol. Sci., 10: 1371-1379.

Rozhevits, R.Y. and B.K. Shishkin, 1934. Gramineae. In: Flora of the U.S.S.R., Komarov, V.L. (Ed.)., Vol. 2. Koeltz Scientific Books, USA., pp: 227-228.

Sneath, P.H.A. and R.R. Sokal, 1973. Numerical Taxonomy. W.H. Freeman and Company, San Francisco, ISBN: 0-7167-0697-0.

Tutin, T.G., V.H. Heywood, N.A. Burges, D.M. Moore, D.H. Valentine, S.M. Walters and D.A. Webb, 1980. Flora Europaea. Vol. 5. Cambridge University Press, Cambridge, Pages: 259.

Wu, Z.Y., P.H. Raven and D.Y. Hong, 2006. Flora of China (Poaceae). Science Press, Beijing and Missouri Botanical Garden Press, St. Louis, USA., pp: 492-493.