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ASSESSMENT OF MORPHOLOGICAL ATTRIBUTES OF DATE PALM ACCESSIONS OF DIVERSE AGRO-ECOLOGICAL ORIGIN

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Abstract

Sixteen Pakistani date palm cultivars from diverse origins were characterized morphologically to assess the similarity level, the overall point of polymorphism and important agronomic traits existing in the germplasm present in Pakistan. Forty two qualitative and quantitative features were explored and subjected to multivariate analyses. The results brought out important differences in phenotypic characters in all date palm cultivars. Principal component analysis (PCA) indicated that trunk length and diameter, total number of leaves, rachis length, leaflets length and width, number of leaflets per side, number of pinnae planes, length and grouping of spines were highly divergent. Similarly cluster analyses (CA) also revealed phenotypic diversity among date palm cultivars and, some close association or heterogeneity was also observed within cultivars of the same origin.

Key words: Date palm, Morphology, Multivariate analysis, PCA, CA.

Introduction

The date palm (*Phoenix dactylifera* L.) is an angiosperm, monocotyledonous and dioecious (2n=36) plant, engaged in the social and economic importance of the oasis ecosystem of Balochistan, Khyber Pakhtunkhwa (KPK), Irrigated plains and Suleman mountain pediments of Punjab; and plains and semi-desert like zones of Sindh, Pakistan (Markhand *et al*., 2010; Haider *et al*., 2013). Date industry is well adapted throughout the Pakistan with annual production of 70 thousand tons (Anon., 2012), contributing 10.3% of the total world production. Aseel, Dhakki, Begum Jungi and Koharba are among the most important native date palm cultivars and numerous other local cultivars are grown in different agro-ecological zones of Pakistan (Iqbal *et al*., 2012). Farmers have denominated the cultivars on the basis of shape and color of the fruits or the presence of specific location (Ahmed *et al*., 2011). Along with this, the date palm is selected for cultivation on the basis of better fruit quality and post-harvest life. Each cultivar is obtained from the elite successor individual off-spring or seed-based selection. Centered on the botanic interpretation, there are about 244 cultivars in Morocco, 250 in Tunisia, 370 in Iraq, 400 in Iran (Zaid & de Wet, 2002), 400 in Sudan (Osman, 1984), 325 in Pakistan (Botes & Zaid, 2002; Jamil *et al*., 2010) and along with surplus varieties in new date palm emergent states. About 5000 different date palm cultivars are known to present worldwide (Jaradat & Zaid, 2004).

The date palm develops a cylindrical, unbranched and large stem (10-20 m tall) marked with leaf scars, and generally produces basal suckers. The adult date palm has a crown of up to 100-125 green leaves with ca. 150 pinnae, and having acanthophylls on the petiole. Leaves, pinnae and acanthophylls vary in length depending on cultivars (Chao & Krueger, 2007). Only female trees yield fruits and fifty female trees can be pollinated manually by one male tree. The average period of date palm life may extend to over 100 years (Hashempour, 1999). Date fruit is a single-seeded oblong berry with fleshy mesocarp and membranous endocarp (Mansour, 2005).

The characterization of germplasm is of great importance for cultivar identification, conservation, utilization and advancement in fruit crops (Al-Moshileh *et al*., 2004; Mehmood *et al*., 2013). This characterization needs a generous set of phenotypic records that are sometimes problematic to measure as a result of sensitivity to the environmental influences (Rao, 2004) or vary with the progressive stages of the plant development. This important crop is threatened by genetic erosion, conversion of agricultural land, pest and diseases. Many studies have highlighted this concern, and used either molecular markers (Zehdi *et al*., 2005, 2012) or phenotypic data (Hammadi *et al*., 2009; Ahmed *et al*., 2011) to classify dissimilar date palm cultivars. The vegetative parameters are informative for description, phenotypic diversity and phylogenic relationship among date palm ecotypes.

In this study 16 different cultivars were selected from diverse ecological origins of Pakistan. The aim of the research was to describe the phenotypic diversity of Pakistani date palm cultivars, and assess similarity relationship for date breeding programs.

Material and methods

Plant material and measurements: There were 16 cultivars included in this study, coming from various origins and grown in diverse ecological conditions in Pakistan (Table 1). This study is based on the description of forty two (42) vegetative traits of the date palm, out of which 27 were measured traits (M1-M27) and 15 were visually observed traits (V1-V15) as described in Table 2. These characters have already been reported as a standard descriptor to characterize date palm (IPGRI, 2005; Rizk & Sharabasy, 2006, 2007). All measurements were performed in triplicate using measuring tape and different geometrical tools (protractor) to measure the angles.

Table 1. Name and origin of date palm cultivars

Serial No.	Cultivars	Origin
1.	Khadrawy I	Iraq
2.	Koharba	Pakistan
3.	Hillawi I	Iraq
4.	Deglet Nour	Algeria
5.	Angoor	Pakistan
6.	Champa Kali	Pakistan
7.	Hillawi II	Iraq
8.	Shamran II	Iraq
9.	Shamran I	Iraq
10.	Khadrawy II	Iraq
11.	Neelam	Pakistan
12.	Zaidi	Iraq
13.	Aseel	Pakistan
14.	Karblain	Iraq
15.	Danda	Pakistan
16.	Peela Dora	Pakistan

Data analysis: The measured data were analyzed through principal component analysis (PCA) to identify the correlated quantities and dissimilar sets of uncorrelated variables using MiniTab (Ver. 6). The results are presented in the diagram putting the calculations against the components along with the high positive and negative loadings of the traits. The correlation between examined variables was evaluated by Pearson's correlation coefficient (Snedecor and Cochran, 1968). The cluster analysis was performed using IBM SPSS (Ver. 20), aimed on unweighted pair-group method with arithmetic averages (UPGMA) and Euclidean distances as similarity measures were applied to analyze the interactions between cultivars.

Results

Mean values of the measured parameters (M1-M27) are given in Table 4, while the visual observation parameters (V1-V15) are given in Table 5. The data depicted great variability between cultivars for all studied parameters.

Principal component analysis (PCA): Table 3 sums up the results of PCA between 16 date palm cultivars. The principal component of first three axes accounted for 45.83, 24.09 and 10.64%, respectively, among all date palm cultivars based on the forty two (42) vegetative traits. The results revealed that petiole length (M10), total number of leaves estimated (M5) and leaf sheath length (M8) had high positive loadings, whereas the angle between pinnae planes (M26), number of pinnae left side (M19) and number of pinnae right side (M18) had high negative loadings in the PC1 axes. In the PC2 axes, mean number of acanthophyll per side (M14), height of the basal root cone (M1) and leaf sheath width at top (M7) had high positive loadings while length of longest acanthophyll (M17), total numbers of leaves estimated (M5) and length of smallest acanthophyll (M15) had high negative loadings. The contribution of the most important variables revealed that the apical pinnae length (M24), median pinnae length (M22) and median pinnae width (M23) had high positive loadings, whereas rachis length point of beginning of lateral torsion (M13), mean numbers of acanthophyll per side (M14) and trunk perimeter (M3) had high negative loadings in the PC3 axes. The Figs. 1 & 2 represents the cultivars on the plane (1-2) and (1-3) axes showed significant diversity between Deglet Nour and Shamran II cultivars in the first principal component. Deglet Nour is characterized by the large trunk size and leaf sheath length; whereas, Shamran II has a larger length of acanthophyll and angle between pinnae planes (upper third). In the second axis, the Zaidi cultivar had greater height of the basal root cone, large number of pinnae on both sides (left and right) and higher angle between pinnae planes (lower third) as compared to Peela Dora and Hillawi II characterized with large apical pinnae length and angle between pinnae planes (lower third).

Correlation matrix: The correlation matrix between explored characters presented in Table 6. Leaf sheath width at top (M7) correlated positively with the trunk height (M2). Petiole length (M10) correlated positively to number of leaves (M5) and leaf sheath length (M8). Rachis length spiny part (M12) correlated positively with the petiole length (M10) and total rachis length (M11). Mean number of acanthophyll (M14) was positively correlated with height of the basal root cone (M1), whereas, length of the smallest acanthophyll (M15) was positively correlated to number of leaves (M5). Number of pinnae right side (M18) was negatively correlated to the leaf sheath length (M8). Number of pinnae left side (M19) and right side (M18) correlated positively, but negatively with petiole length (M10). Apical pinnae length (M24) had negative correlation with number of pinnae right side (M18). Apical pinnae width (M25) correlated positively with petiole length (M10); whereas, highly negative correlation with number of pinnae right side (M18) and number of pinnae left side (M19) was observed. Angle between pinnae planes lower third correlated negatively with petiole length (M10), total rachis length (M11) and rachis length (spiny part), (M12).

Cluster analysis (CA): The dendrogram represented that sixteen (16) morphologically explored date palm cultivars assembled into two large phenotypically correlated clusters (Fig. 3). The dissimilarity distance ranged 20-78. The first main cluster contained only Zaidi cultivar that was entirely different from all other selected cultivars. The second main cluster had two sub clusters. The first sub cluster enclosed four cultivars (Deglet Nour, Hillawi II, Champa Kali and Angoor), while, the second sub cluster confined the rest of the eleven cultivars (Neelum, Koharba, Aseel, Hillawi I, Danda, Karblain, Khadrawy I, Khadrawy II, Shamran I, Peela Dora and Shamran II). In this final sub cluster group Khadrawy I was closely related with Khadrawy II and Shamran II. Based on the dendrogram, the cultivars of the same denominations like Khadrawy I, Khadrawy II, Shamran I and Shamran II were placed in the same group, thus showing close homogeneity. In contrast Hillawi-I and Hillawi-II were heterogenous within the cultivars of the same denominations. Cluster analysis also depicted that Zaidi and Deglet Nour cultivars were distantly correlated with other selected cultivars of diverse origins. This dendrogram included cultivars of different origin like Deglet Nour (Algeria), Karblain (Iraq) and Aseel (Pakistan).

Table 2. Character used for date palm cultivars identification.

Characters	Unit	Codes
Height of basal root cone	cm	M1
Trunk height (from ground to lowest green leaf)	cm	M2
Trunk perimeter (not including leaf sheaths)	cm	M3
Number of basal suckers		M4
Number of leaves (estimate)		M5
Leaf sheath width at base	cm	M6
Leave sheath width at top	cm	M7
Leaf sheath length	cm	M8
Petiole width at top	cm	M9
Petiole length	cm	M10
Rachis length (total)	cm	M11
Rachis length (spiny part)	cm	M12
Rachis length (point of beginning of lateral torsion)	cm	M13
Mean number of acanthophyll per side		M14
Length of smallest acanthophyll	cm	M15
Length of median acanthophylls (4 measures)	cm	M16
Length of longest acanthophyll	cm	M17
Number of pinnae (right side)		M18
Number of pinnae (left side)		M19
Basal pinnae length	cm	M20
Basal pinnae width	cm	M21
Median pinnae length	cm	M22
Median pinnae width	cm	M23
Apical pinnae length	cm	M24
Apical pinnae width	cm	M25
Angle between pinnae planes(lower third)		M26
Angle between pinnae planes(upper third)		M27
Crown shape (spherical, hemispherical, erect)		V1
Crown density (very dense, dense, open)		V2
Leaf lateral torsion (none, moderate, strong)		V3
Leaf bases (persistent/ caducous)		V4
Fiber density and solidity (thin, medium, thick)		V5
Petiole color (green, yellowish green)		V6
Grouping of acanthophylls (single, double, three, four)		V7
Transition spine/pinnae (sharp/progressive)		V8
Color of pinnae (light green, green dark green)		V9
Aspect of pinnae (soft, rigid, spiny, stiff, bending)		V10
Wax cover of pinnae (none, thin, medium, thick)		V11
Grouping pattern of pinnae (Alternate, opposite), (lower third of leaf)		V12
Number of pinnae planes on each side of rachis (1, 2, 3 plane), (lower third of leaf, one side)		V13
Grouping pattern of pinnae (Alternate, opposite), (upper third of leaf)		V14
Number of pinnae planes on each side of rachis (1, 2, 3 plane),		V15

M represents measurement and V is indicating visual observed characters

Table 3. Eigenvalues, variation proportion and eigenvectors linkage with first three axes of the PCA in 16 date palm cultivars (Table 3 for parameter labels).

Axe	1	2	3
Eigenvalue variation	6.75	4.37	4.01
Variance proportion			
Individual %	45.83	24.09	10.64
Cumulative %	45.83	69.92	80.56
Eigenvectors*	M10 (0.91)	M14 (0.67)	M24 (0.78)
	M5 (0.77)	M1 (0.63)	M22 (0.52)
	M8 (0.70)	M7 (0.58)	M23 (0.51)
	M26 (-0.72)	M17 (-0.53)	M13 (-0.80)
	M19 (-0.66)	M5 (-0.47)	M4 (-0.60)

*Only parameters with high loadings in three principal components were shown.

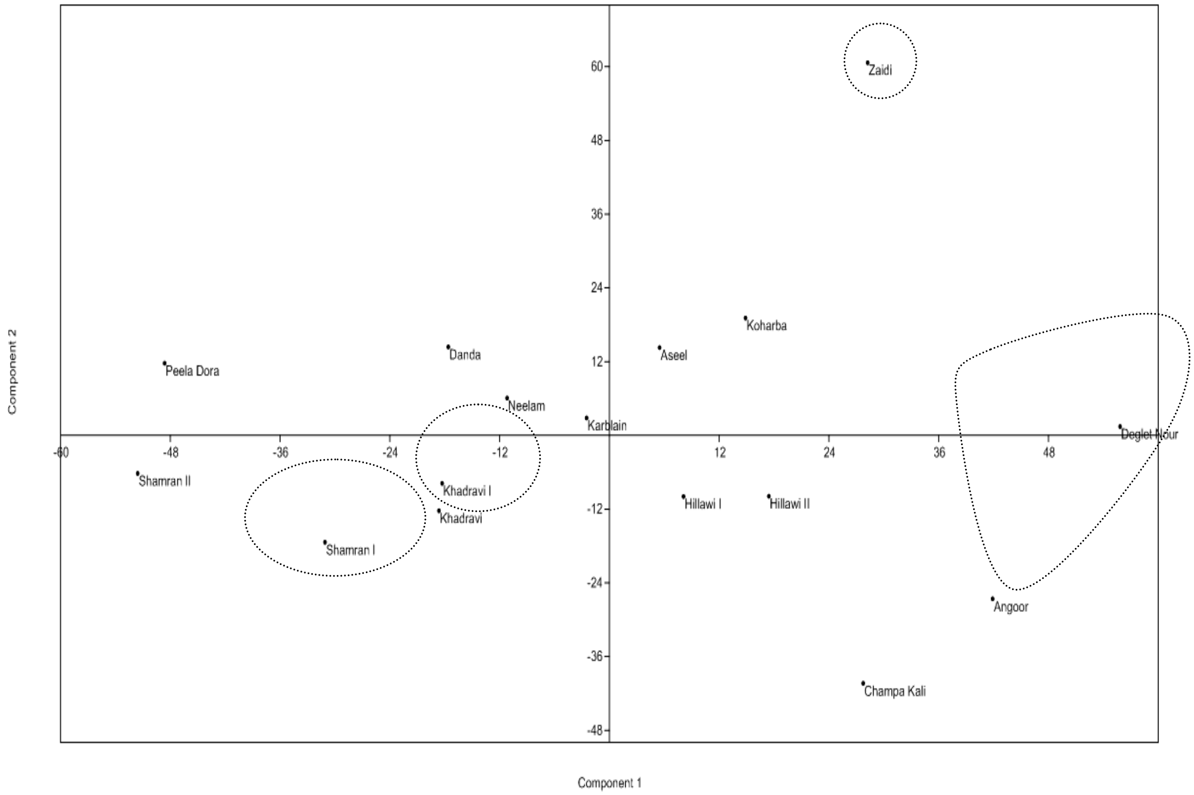

Fig. 1. Graphic represented the date palm cultivars in relation to date palm 1-2 axes of PCA.

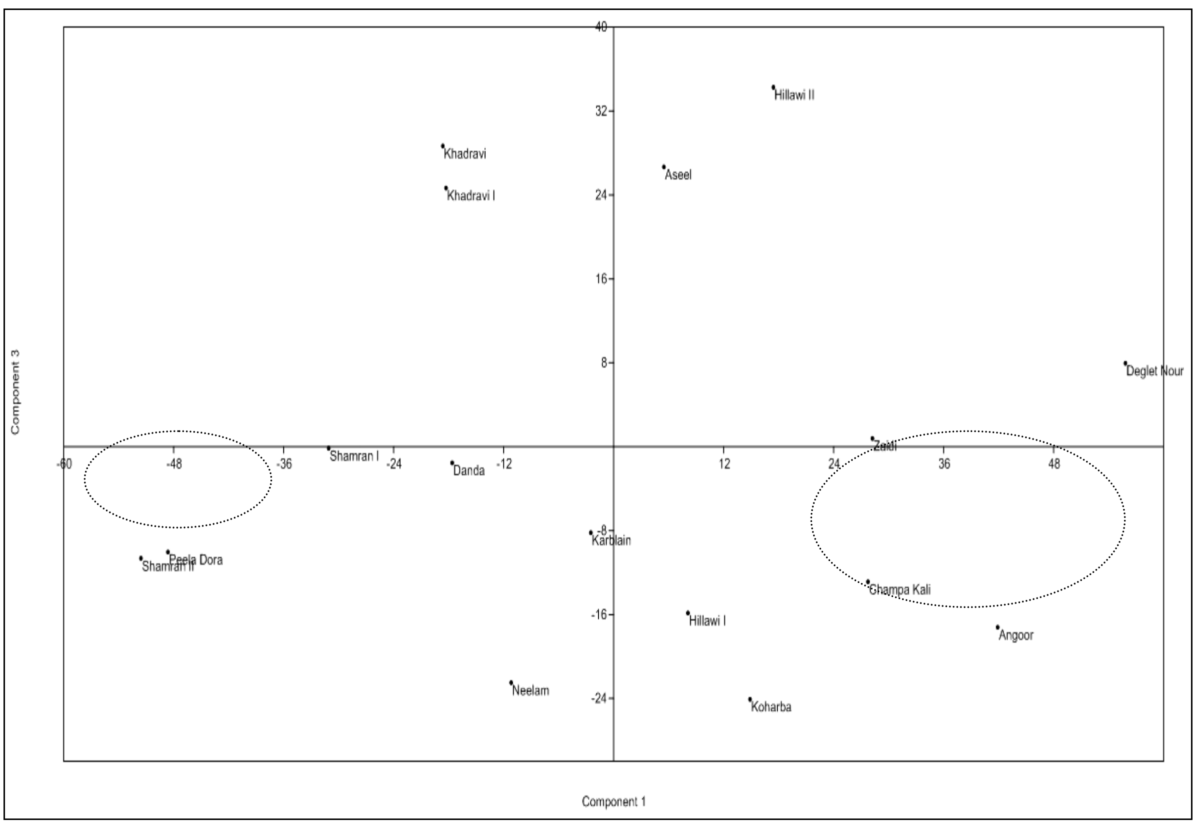

Fig. 2. Graphic represented the date palm cultivars in relation to date palm 1-3 axes of PCA.

Table 4: Mean values of measured parameters in 16 date palm cultivars (see table 2).

Cultivars	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14	M15	M16	M17	M18	M19	M20	M21	M22	M23	M24	M25	M26	M27
Khadrawy I	27.5	195	165	0	39	10	5	32.5	3.75	120	345	87.5	82.5	13	2.5	6.25	8.75	95	96	40	1	47.5	3	26.25	2.25	30	20
Koharba	0	332.5	165	0	35	8	6.5	14.25	3.75	83.25	327.5	72.5	57.5	7	1.25	17.5	8.75	97	93	46.75	0.75	49.5	3	20.25	1	65	15
Hillawi I	0	305	170	2	27	9.5	8.5	37.5	3	110	327.5	60	86	7	0.75	7.5	14.25	85	86	37.5	1	37.25	3.25	23	2.5	34	19
Deglet Nour	65	392.5	147.5	0	37	11	8.5	45	3.75	132.5	382.5	92.5	57.5	19	2.5	11.25	15.5	86	85	52.5	1.75	58.25	3	40	2.25	30	20
Angoor	0	362.5	192.5	0	47	10	5.75	32.5	3.5	115	405	86.25	97.5	12	2.25	6.25	14.75	89	87	49.25	1.25	48.75	3	25	1.75	30	20
Champa Kali	0	312.5	245	4	45	8.75	5.5	27.5	3.25	126.25	412.5	96.25	97.5	9	2.25	8	12	89	86	42.5	1.5	43.75	3.75	23.25	1.75	30	15
Hillawi II	0	272.5	180	0	34	11.25	6.25	12.5	3.75	102.5	402.5	97.5	86.25	11	1.25	8.75	12	108	110	57.75	1.5	51.25	4	19.75	1.5	20	15
Shamran II	0	172.5	175	0	32	12.25	5.25	21.25	2.5	82.5	282.5	52.5	55	9	2.25	12	23.75	86	84	55	1.5	48.75	3.25	25.5	1.5	45	35
Shamran I	0	200	175	0	35	8.75	4.75	22.5	4.75	76.25	350	56.25	42.5	9	3	8.75	16.5	91	93	43.5	0.75	47.5	3.75	23.75	1.5	30	33
Khadrawy II	25	207.5	172.5	0	37	11.25	5	37.5	3.75	102.5	347.5	52.5	45	13	3.75	7.5	13.75	91	93	36.25	1	52.5	3.5	26.25	1.75	30	20
Neelam	0	267.5	177.5	0	41	8.75	5.5	27.5	3.5	97.5	312.5	60	63.75	10	3	6.5	15	94	96	49.5	1.5	45.25	3.25	32.5	1.5	60	23
Zaidi	42.5	367.5	145.75	0	22	7.5	5.5	18.75	3.75	65	327.5	42.5	58	14	0.5	7.25	10	116	117	29.75	1	46.5	3	20.5	0.75	70	25
Aseel	0	277.5	132.5	2	32	13.75	5	36.25	4	97.5	317.5	67.5	83.75	10	1.25	5.75	8.75	102	104	38	1.5	41	3.5	19.75	1.5	30	15
Karblain	40	277.5	180	2	43	12.25	5.5	32.5	4.5	98	337.5	62.5	88	6	3.75	10	14.5	98	101	42.25	0.5	40.5	2.25	18.25	1	45	40
Danda	35	240	160	0	30	8.75	5	15.5	3	78.5	302.5	55	77.5	15	1.25	7.25	13.75	112	114	46.25	1.25	46.25	3.5	20	1	45	20
Peela Dora	0	185	182.5	0	28	6.25	5	14.75	2.25	76.5	315	65.75	53	10	2	9	11	90	93	44.5	1.5	49.5	2.75	36.25	2	65	60

Table 5. Visuals observation parameters of 16 date palm cultivars (see table 2).

Cultivars	V1	V2	V3	V4	V5	V6	V7	V8	V9	V10	V11	V12	V13	V14	V15
Khadrawy I	HS*	D*	M*	P*	Med*	YG*	S**	SHP*	G*	Stiff	None	ALT*	2	OPT*	1
Koharba	HS*	D*	M*	P*	None	G*	S**	SHP*	G*	Stiff	Thin	OPT*	2	OPT*	2
Hillawi I	HS*	O*	M*	P*	None	YG*	S**	SHP*	G*	Stiff	Thin	OPT*	3	OPT*	3
Deglet Nour	HS*	D*	M*	P*	None	G*	S&D*	SHP*	G*	Stiff	Thin	OPT*	2	ALT*	2
Angoor	HS*	D*	M*	P*	Med*	YG*	S**	SHP*	LG*	Stiff	Thin	ALT*	2	ALT*	2
Champa Kali	HS*	D*	S*	P*	None	YG*	S**	SHP*	LG*	Stiff	Thin	ALT*	2	OPT*	2
Hillawi II	HS*	D*	M*	P*	Med*	G*	S**	SHP*	G*	Stiff	Thin	ALT*	2	OPT*	2
Shamran II	HS*	D*	M*	P*	Med*	G*	S&D*	SHP*	G*	Stiff	Thin	OPT*	3	OPT*	1
Shamran I	HS*	D*	M*	P*	Med*	YG*	S**	SHP*	G*	Stiff	Thin	ALT*	3	OPT*	1
Khadrawy II	HS*	D*	M*	P*	None	G*	S**	SHP*	G*	Stiff	None	OPT*	2	ALT*	1
Neelam	HS*	D*	M*	P*	None	G*	S**	SHP*	G*	Stiff	None	OPT*	2	OPT*	2
Zaidi	HS*	O*	M*	P*	None	YG*	S**	SHP*	G*	Stiff	Thin	OPT*	3	OPT*	2
Aseel	HS*	D*	S*	P*	None	YG*	S**	SHP*	G*	Stiff	Thin	OPT*	3	OPT*	3
Karblain	HS*	VD *	M *	P*	None	YG*	S**	SHP*	G*	Stiff	None	OPT*	2	OPT*	2
Danda	HS*	D *	M *	P*	None	G*	S**	SHP*	G*	Stiff	None	OPT*	2	OPT*	2
Peela Dora	HS*	D *	M *	P*	None	YG*	S&D*	SHP*	G*	Stiff	None	ALT*	2	ALT*	2

HS* (Hemi-spherical), D* (Dense), O* (Open), VD* (Very Dence), M* (Moderate), S* (Strong), P* (Persistent), Med** (Medium), YG* (Yellowish Green), G* (Greenish), LG* (Light Green), S**(Single), S&D* (Single and Double), SHP* (Sharp), ALT* (Alternate), OPT* (Opposite)

Table 6. Pearson's correlation matrix between selected parameters in date palm cultivars (see table 2).

Correlations

	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14	M15	M16	M17	M18	M19	M20	M21	M22	M23	M24	M25	M26
M2	.318																									
M3	-.406	-.073																								
M4	-.174	.192	.486																							
M5	-.081	.121	.572*	.257																						
M6	.104	-.055	-.247	.203	.261																					
M7	.476	.627**	-.134	-.193	.221	.102																				
M8	.347	.268	-.133	.304	.362	.513*	.179																			
M9	.249	.222	-.209	.045	.312	.314	.147	.266																		
M10	.149	.333	.318	.390	.636**	.363	.401	.708**	.085																	
M11	.045	.475	.505*	.255	.563*	.036	.421	.207	.298	.651**																
M12	-.053	.320	.394	.232	.559*	.131	.526*	.163	.057	.762**	.787**															
M13	-.133	.326	.356	.594*	.414	.264	-.071	.178	-.004	.525*	.459	.542*														
M14	.673**	.251	-.363	-.440	-.106	-.018	.487	.226	-.043	.222	.224	.166	-.178													
M15	.139	-.374	.301	-.033	.653**	.278	.014	.376	.302	.256	.085	.001	-.223	-.060												
M16	.004	.120	-.021	-.164	-.046	-.099	.480	-.306	-.025	-.180	-.138	.045	-.368	-.248	-.017											
M17	-.042	-.256	.164	-.149	.114	.274	.013	.097	-.213	-.038	-.183	-.255	-.243	-.044	.409	.130										
M18	.261	.134	-.384	-.173	-.406	-.086	-.069	-.503*	.218	-.494	-.116	-.220	.100	.209	-.480	-.168	-.457									
M19	.271	.029	-.419	-.187	-.433	-.062	-.152	-.456	.236	-.511*	-.166	-.280	.066	.198	-.403	-.268	-.439	.980**								
M20	-.175	.007	.103	-.085	.670**	.283	-.129	.344	.560*	.224	.245	.065	.150	-.124	.497	-.205	.160	-.233	-.232							
M21	-.111	-.022	.259	.085	.519*	.230	.120	.317	.033	.329	.366	.297	.084	.286	.401	-.317	.302	-.370	-.359	.452						
M22	.196	-.069	-.134	-.504*	.026	.112	.475	-.146	.195	-.068	.302	.208	-.483	.427	.257	.237	.025	.064	.067	-.039	.277					
M23	.126	.088	-.187	.017	.186	.316	.434	.521*	.099	.392	.008	.141	-.326	.351	.282	.089	.223	-.414	-.417	.102	.466	.201				
M24	.201	-.016	-.009	-.311	.080	-.234	.420	.301	-.343	.295	.023	.185	-.401	.455	.310	.015	.206	-.547*	-.497	-.177	.349	.296	.529*			
M25	-.099	-.099	.146	.118	.135	.063	.037	.562*	-.286	.668**	.252	.428	.119	.146	.121	-.242	.074	-.717**	-.656**	-.021	.222	-.083	.324	.582*		
M26	.039	.050	-.175	-.259	-.405	-.601*	-.048	-.481	-.296	-.661**	-.596*	-.539*	-.403	-.155	-.216	.335	-.140	.267	.240	-.374	-.447	-.151	-.256	.098	-.489	
M27	-.023	-.477	.071	-.179	-.206	-.287	-.240	-.260	-.293	-.456	-.397	-.357	-.381	-.223	.300	.090	.257	-.197	-.095	-.263	.018	.151	-.302	.346	-.006	.437

**Correlation is significant at the 0.01 level

*Correlation is significant at the 0.05 level

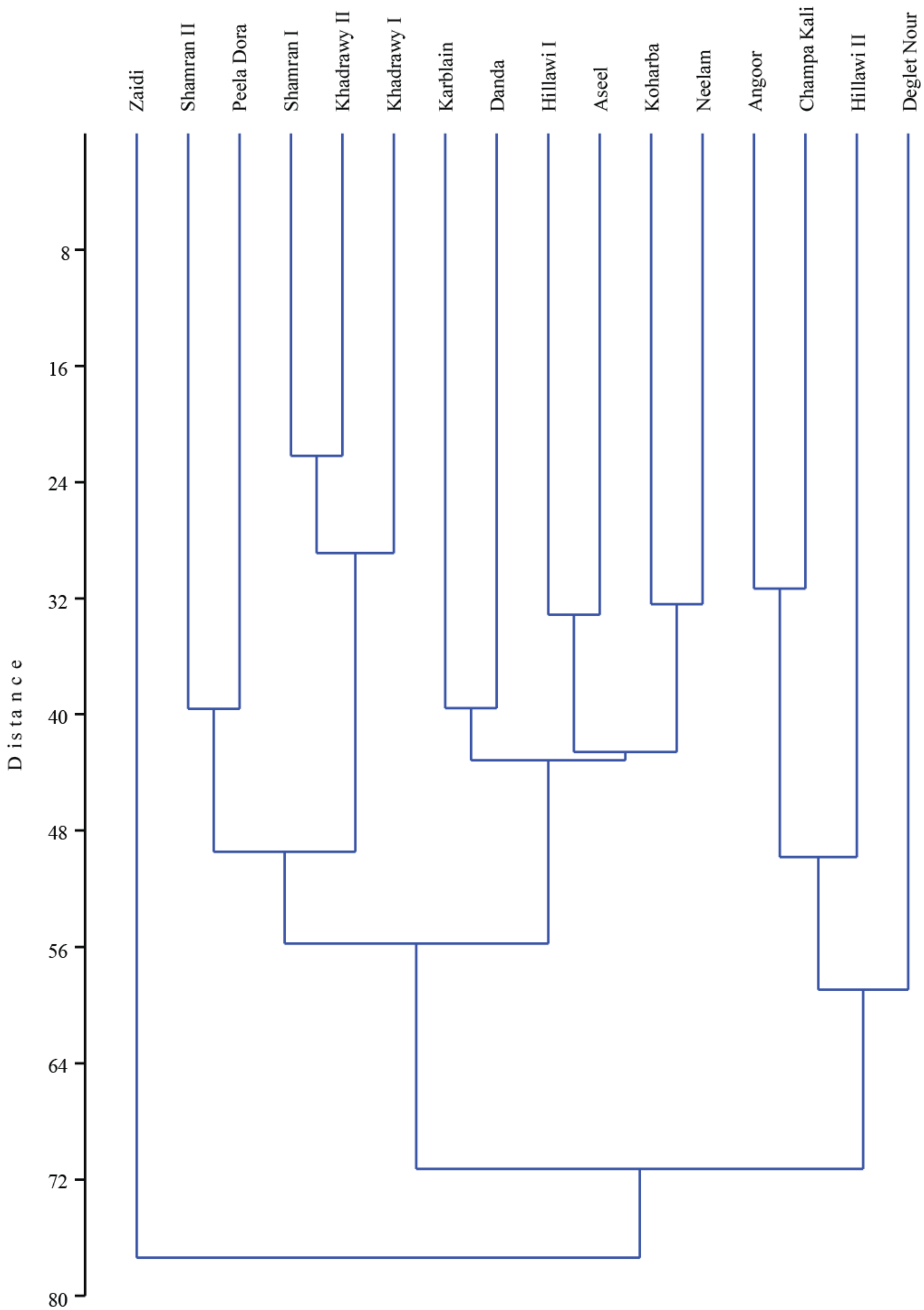

Fig. 3. Dendrogram of hierarchical clustering of date palm cultivars based on 68 vegetative and reproductive attributes.

Discussion

The overall forty two (42) quantitative and qualitative traits were explored and recorded to determine the phenotypic diversity in sixteen (16) Pakistani date palm cultivars. Morphological traits such as leaves, number of leaflets, length and grouping of spines, spathe, fruit and spideces possess quantitative markers mainly used for identification, description, differentiation and characterization of date palm cultivars (Salem *et al*., 2008; Eissa *et al*., 2009; Hammadi *et al*., 2009). This study revealed the broad range of variability in measured (M1-M27) and visual (V1-V15) parameters (Tables 4 & 5). In visual parameters Karblain cultivar showed the more dense structure as compared to other cultivars. Similar findings also have been reported in previous publications on characterization of date palm. A similar study on twenty six (26) Moroccan date palm accessions by using twenty six (26) vegetative parameters depicted higher range of phenotypic polymorphism (Elhoumaizi *et al*., 2002). The studied parameters were of great importance for the cultivar identification, but also selection can be made for quality assurance and resistance against diseases and stress because most of the characters are sensitive to environmental conditions.

Principal component analysis was used for traits identification and data depicted that measured (M1-M27) characters like plant height, leaf length, number and grouping of leaflets, leaflet length and width and number and grouping of spines, spine length possessed a greater proportion of the observed variability. Whereas, Pearson’s coefficient correlation depicted that there was high positive and negative correlation between all recorded parameters. The presented correlation among examined parameters proposed that date palm tree architecture is well agreed. Ahmed *et al*. (2011) studied phenotypic diversity in twenty one (21) date palm cultivars by the use of PCA analysis. The results showed great variations in 30 selected vegetative traits and were similar to these results.

The cluster analysis publicized the typical continuous phenotypic variations that differentiated the indigenous date palm cultivars and above mentioned clustering of dendrogram strongly supported this statement. To be sure, clustering of the cultivars did not ensure the source-of-collection base which suggested that there was a vast interchange of planting material from one ecology to another. Similar study on morphology of date palm (Salem *et al*., 2008; Hammadi *et al*., 2009; Ahmed *et al*., 2011; Taain, 2013), fig (Saddoud *et al*., 2008), ber (Razi *et al*., 2013) and olives and pomegranate accessions (Ouazzani *et al*., 1995; Nafees *et al*., 2015) has been previously stated. It is worth noting that two separate cultivars (Khadrawy I and Khadrawy II, Shamran I and Shamran II) were phenotypically almost the same and closely associated with each other, but Zaidi and Deglet Nour cultivars were distantly related to other studied cultivars (Fig. 3).

This type of description can not properly delineate the cultivar documentation problem. Indeed, numerous diverse accessions might possess the same aspect in spite of their diverse genome. Advances in the development of more effective markers (microsatellite) may provide a precise genotypic differentiation and overcome this problem (Zehdi *et al*., 2005, 2012). Indeed, a precise description of the phenotypic and genetic diversity of the Pakistani gene pool requires a combination of biochemical, morphological and molecular markers.

Conclusions

In the scenario of the present subject, we have reasoned that the quantitative and qualitative traits possessed a useful approach to assess the phenotypic diversity in date palm accessions. The results revealed considerable diversity within date palm cultivars. Although, accurate characterization of cultivars need a huge set of morphological as well as biochemical and molecular (isozymes) markers.

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