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Seed Diversity of Indigenous Field Peas (*Pisum sativum* L.) Germplasm Collection in Oman

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Abstract

Pea (*Pisum sativum* L.) is a field crop cultivated in most countries of the Arabian Peninsula for both food and fodder consumption during winter. This paper presents the results of indigenous germplasm collections in Oman and assessment of their seed diversity. 27 seed samples/accessions of field peas were collected during collecting missions of indigenous legume crops from 2008 to 2011. South Batinah-coastal governorate represented by Rustaq (15) had the highest, followed by Dhahira & Buraimi governorates (8), Al-Dakhliya (Interior) governorate (2), Sharqiya (eastern) governorate (1) and North Batinah-coastal governorate (1). Seed accessions were found diverse for three seed traits and seed color. Seed length varied from 0.305 cm to 0.720 cm whereas seed width varied from 0.295 cm to 0.690 cm. 100-seed weight ranged from 4.500 g to 21.9 g. With respect to seed color, six accessions viz. Collection No. 25 (tan-light), No. 78 (dark green, mottled), No. 82 (light green), No. 173 (dark green, dark brown, mottled), No. 178 (brownish green, mottled) and No. 314 (cream, light pink) were homogenous (pure) whereas the remaining 21 seed accessions were heterogeneous (mixture) with various colors such as white cream, cream, light green, tan, light brown, dark brown and black with mottled nature. The collections were grouped into 10 genetically diverse clusters based on the Principal Component Analysis (PCA) using seed traits which revealed significant contribution of seed length (34.378%) and 100-seed weight (34.182%) to the total variation existing in indigenous field pea germplasm collected across all the governorates of Oman.

Keywords: diversity, collections, seed characters, seed color, pea

1. Introduction

Oman with the characteristic location has its northern part that represents Asian countries and its southern part, to the African continent in both climate and culture. It is the second largest country in the Arabian Peninsula with 85473.10 ha of agricultural land under cultivation (MAF, 2017). Fruits occupy 36.11% followed by perennial and annual fodder crop species (39.40%), vegetables (19.72%) and field crops (4.77%). Of the field crops, field pea (*Pisum sativum* L.) is considered as an integral crop among the few farmers who grow it for both food and green fodder (MAF, 2005).

Pea being one of the oldest domesticated crops is grown during winter in temperate and subtropical regions of the world for both food and fodder. Canada is the major producer followed by USA, India, Russia, France and China (Gixhari et al., 2014). It is known for its ability to fix atmospheric nitrogen to improve soils and protein source (Santalla et al., 2001; Esposito et al., 2007). It is grown throughout Oman in both plains and mountains as a winter crop from November to March. Its exact area, productivity and yield figures are not documented. The seeds can be consumed fresh and green as a part of salad or as vegetable. Dried seeds are also consumed after cooking. The plant can be used as green or dry forage.

In peas seed size is considered as an important trait as it directly influences productivity (Syed et al., 2014). The seed sizes in field pea range from < 12 g per 100 seeds and 27 g (Bhuvaneswari et al., 2017). In this respect, the consumer market in general shows preference for a seed standard from medium to large (15 to 20 g) (Anonymous, 2018). Genetic diversity in the crop species is the key for improvement and development of effective conservation strategies (Hodgkin, 1997; Egbadzor et al., 2013; Mafakheri et al., 2017). Knowledge of genetic diversity available in the indigenous germplasm is very useful for promoting the efficient use of genetic variations in breeding programs through proper selection of cross combination of parents. There are several studies undertaken on genetic diversity of pea populations not only in the past (Hoey et al., 1996; Simioniuc et al., 2002; Taran et al., 2005; Esposito et al., 2007; Zahir et al., 2007; Yadav et al., 2009) but also recently (Kumari et al., 2013; Kole et al., 2015; Ouafi et al., 2016; Khan et al., 2016; Bhuvaneswari et al., 2017) using both morphological and yield characters, and molecular markers.

In Oman, a range of ecotypes of field crops including that of field pea is grown mainly for their dual food value, and inherent interest due to diverse agro-climatic conditions. However, due to fluctuating land use patterns and the gradual shift in cultivation of high-yielding commercial crops, the indigenous germplasm of field crop species, including field pea is slowly getting extinct. Since early 1980s, several collecting missions were carried out in Oman either independently or jointly with national and international organizations to collect and conserve germplasm of crops grown (Al-Saady et al., 2014, 2018a, 2018b). During these missions the most of the landraces of alfalfa, wheat, barley and grain legumes like chickpea, faba bean, cowpea, lentil, fenugreek etc. including field peas were collected and conserved in local conservation facilities. In continuation of above activities, a series of joint collection missions between the Sultan Qaboos University and the Ministry of Agriculture & Fisheries of Oman were undertaken from different sites within all the governorates of Oman during 2008-2011 to conserve the genetic diversity of vast indigenous germplasm available in legume crops of Oman. This paper presents the results of collecting missions of indigenous germplasm of field pea in addition to a brief account of their diversity in respect of three seed traits, having marketing significance.

2. Materials and Methods

Seven exploration trips for the collection of indigenous germplasm of alfalfa and food legumes like chickpea, faba bean, cowpea, lentil, field pea, mung bean and pigeon pea, and the medicinal legume fenugreek were undertaken from April 2008 to March 2011 in different Governorates of Oman with the support of the staff of Agriculture Development Centers of the Ministry of Agriculture and Fisheries following standard method of collecting missions (IPGRI, 1995; Hay & Probert, 2011) from individual farmers, farmers-fields and stores, and Agriculture Development Centers with passport data and site descriptions including GPS data, electrical conductivity and pH of soil and water samples (Table 1). Remote and unexplored localities were prioritized.

The area covered during the trip lied between coastal and interior plains from 12-1983 m altitude. The collecting routes were systematically followed as per the plan in each of seven exploration trips in all the governorates. The collecting sites within the wilayats of governorates were located at least 25 km distant as they were so chosen to avoid collecting several seed samples of similar genotype.

A random sampling method was applied for most leguminous crops, where populations were large, otherwise, it was selective. Sampling was done from farmers' household stores and from harvested lots, together with individual sampling from fields. Samples were in the form of pods or seed. Standard passport data for each accession were recorded at the time of collection, including crop name, botanical name, local name of the variety or landrace, village, wilayat and Governorate and sample type, sample method, farmer's name, source of collection, and any special feature of the collection, including indigenous knowledge (IK), if any. Each accession was subsequently assigned an indigenous serial collection number according to collection, irrespective of crop species.

Descriptions of each site were recorded with respect to some soil and edaphic characteristics. Soil EC and pH was measured using field EC and pH measuring meters. Slope angle and aspect were assessed using an inclinometer and compass. The longitude and latitude of each collecting site and its altitude were recorded using a Magellan 315 GPS meter (Table 1). Attempts were made to collect root nodules from selected sites for applied microbiological studies. Indigenous food grain legume accessions were collected from 110 sites of which indigenous field pea accessions were collected from 25 sites across all the governorates of the Sultanate.

Seed characters such as seed length and width (cm), test weight (1000 seed), seed color and nature of seed samples (pure or mixture) were determined in the laboratory according to Dijkstra and van Soest (1986). The principal component analysis (PCA) was performed in the extraction of the components using correlated matrix from the crop collection data using XLSTAT software (XLSTAT, 2017).

3. Results

During collecting missions of land races of legume crops, 27 seed samples/accessions of field pea (*Pisum sativum* L.) were collected. South Batinah-coastal governorate represented by Rustaq had the highest accessions, collected (15), followed by Dhahira & Buraimi governorates with 8 accessions. Governorates of Al-Dakhliyah (Interior) with two and Sharqiya-eastern area and North Batinah-coastal governorates with one each, had least number of accessions collected (Table 1).

The collection sites varied in their characteristics and altitude. Altitude ranged from 274 m at site No. 51 of Al Ghasahb, wilayat Rustaq to 1983 m at site No. 24 of Belad Sait, wilayat Rustaq of Batinah South governorate (Table 1). Soil characteristics were also varied. Sites ranged in soil texture from sands, sandy loam, sandy clay, sandy clay loam, clay to loam. Soils were hard, firm or loose, variable-loose to crust and friable. With respect to drainage, soils were either imperfect, free or variable. Soil pH ranged from 3.1 (Site No. 61, Nezooh, wilayat Rustaq, Batinah South governorate) to 9.0 (Site No. 50, Al-hodineeyah, wilayat Rustaq, Batinah South governorate). Soil EC varied from 0.6 dSm^{-1} (Site No.7, Al-Blaad, wilayat Manah, Batinah South) to 9 dSm^{-1} (Sites No. 56 of Atayeeb, No. 57 of Al-Mahdoot and No. 61 of Nezooh of wilayat Rustaq, Batinah South governorate). Soil color ranged from light brown to brown.

Table 1. The sites/locations in different villages, wilayats/districts and governorates/states from where indigenous field pea (*Pisum sativum* L.) accessions were collected, along with their latitudes, longitudes and altitudes

Sl. No.	Site No.	Collection No.	Governorate	Wilayat	Village/location	Latitude (N)	Longitude (E)	Altitude (m)
1	7	OMA 19	Interior	Manah	Manah Al Blaad	22°47.88′	57°35.98′	430
2	9	OMA 25	Interior	Nizwa	Al-Ain, Jabel Akhdar	23°04.07′	57°39.29′	1829
3	23	OMA 64	Batinah South	Rustaq	Haat	23°11.34′	57°24.52′	1978
4	24	OMA 72	Batinah South	Rustaq	Balad Sait	23°11.16′	57°23.51′	1983
5	25	OMA 74	Dhahira	Ibri	Bilad Al-Shahoom	23°23.26′	56°57.57′	884
6	26	OMA 78	Dhahira	Ibri	Bilad Al-Shahoom	23°23.94′	56°57.91′	793
7	27	OMA 81	Dhahira	Ibri	Bilad Al-Shahoom	23°23.71′	56°59.01′	924
8	28	OMA 82	Dhahira	Ibri	Bilad Al-Shahoom	23°22.96′	57°00.57′	947
9	30	OMA 96	Dhahira	Ibri	Alablaah	23°04.84′	56°54.14′	580
10	31	OMA 105	Dhahira	Ibri	Baroot	23°14.55′	57°02.47′	716
11	33	OMA 118	Dhahira	Dank	Aqaib-Kumairah	23°56.15′	56°16.87′	860
12	37	OMA 123	Dhahira	Yanqul	Al-Bouwerdah	23°38.06′	56°29.76′	586
13	38	OMA 134	Dhahira	Yanqul	Al-Bouwerdah	23°41.89′	56°30.33′	623
14	43	OMA 137	Batinah South	Rustaq	Amq	23°17.45′	57°19.72′	285
15	44	OMA 147	Batinah South	Rustaq	Al-Ayeer	23°12.79′	57°27.56′	723
16	50	OMA 149	Batinah South	Rustaq	Al hodineeyah	23°11.15′	57°37.81′	769
17	51	OMA 154	Batinah South	Rustaq	Al Ghasahb	23°24.97′	57°25.92′	274
18	52	OMA 159	Batinah South	Rusaq	Almari	23°27.89′	57°02.19′	678
19	55*	OMA 164	Batinah South	ADC, Rusaq	AL Dahir	-	-	-
20	56	OMA 170	Batinah South	Rustaq	Atayeeb	23°25.40′	57°09.78′	557
21	57	OMA 173	Batinah South	Rustaq	Almahdooth	23°30.52′	57°11.42′	482
22	59*	OMA 178	Batinah South	ADC, Rustaq	-	-	-	-
23	60*	OMA 181	Batinah South	ADC, Rustaq	-	-	-	-
24	61	OMA 185	Batinah South	Rustaq	Nezooh	23°28.92′	57°17.21′	344
25	66	OMA 198	Batihah South	Nakhal	Alqoorah	23°05.38′	57°44.20′	1322
26	108	OMA 267	Sharqiyah	ADC, Ibra	-	-	-	-
27	130	OMA 314	Batinah North	Sohar	Wadi Hibi	23°53.19′	56°32.27′	615

Note. *Samples collected at ADCs (Agriculture Development Centers) located in wilayats of the governorates.

3.1 Variability in Seed Characters

The indigenous field pea accessions, collected, had large variation with respect to all the seed characters studied, i.e. seed length (cm) and width (cm), 100-seed weight (g) and seed color (Table 2). Seed length varied from 0.305 cm (Collection No. 78 at Site No. 26 of Bilad Al-Shahoom, Ibri, Dhahirah) to 0.720 cm (Collection No. 25

at Site No. 9 of Al-Ain, Jabal al-Akhdar, Nizwa, Interior); seed width ranged from 0.295 cm (Collection No. 78 at Site No. 26 of Bilad Al-Shahoom, Ibri, Dhahirah) to 0.690 cm (Collection No. 25 at Site No. 9 of Al-Ain, Jabal al-Akhdar, Nizwa, Interior); 100-seed weight ranged from 4.500 g (Collection No. 78 at Site No. 26 of Bilad Al-Shahoom, Ibri, Dhahirah) to 21.9 g (Collection No. 25 at Site No. 9 of Al-Ain, Jabal al-Akhdar, Nizwa, Interior). With respect to seed color, six accessions—Collection No. 25 (tan-light) of Site No. 9 at Al-Ain, Jabal al-Akhdar, Nizwa, Interior, Collection No. 78 (dark green, mottled) of Site No. 26 at Bilad Al-Shahoom, Ibri, Dhahirah, Collection No. 82 (light green) at Site No. 28 of Bilad Al-Shahoom, Ibri, Dhahirah, Collection Nos. 173 (dark green, dark brown, mottled) and 178 (brownish green, mottled) of Site Nos. 57 and 59 of Al-Mahdooth Hajer Bani Omer, Rustaq, Batinah South, and Collection No. 314 (cream, light pink) of Site No. 130 of Wadi Hibi (Al-Sham), Sohar, Batinah North governorate were homogenous (pure). The remaining 21 seed accessions were heterogeneous (mixture) with seeds of various colors ranging from white cream, cream, light green, tan, light brown, dark brown, black, mottled. The results of analysis of seed colors of these collections indicated the presence of as many as 25 groups of which two groups had two collections each (Collection Nos. 74 & 81 and Collection Nos. 173 & 181) and remaining 23 seed accessions—Collections Nos. 19, 25, 64, 72, 78, 82, 96, 105, 118, 123, 134, 137, 147, 149, 154, 159, 164, 170, 178, 185, 198, 267 and 314, formed groups of their own due to a unique combination of seed colors.

Table 2. Variation among seed characteristics of 27 indigenous field pea genotypes/accessions collected

Sl. No.	Collection No.	Length (cm)	Width (cm)	100 seed weight (g)	Seed color	Seed Color	Governorate
1	OMA 19	0.67	0.635	20.6	Homogeneous	Tan light	Interior
2	OMA 25	0.72	0.69	21.9	Heterogeneous	Green, tan	Interior
3	OMA 64	0.69	0.405	16.2	Heterogeneous	Green, tan, white cream, black	Batinah South
4	OMA 72	0.66	0.61	19.5	Heterogeneous	Light green, tan	Batinah South
5	OMA 74	0.545	0.485	10.3	Heterogeneous	Dark green, brown, mottled	Dhahira
6	OMA 78	0.305	0.295	4.5	Homogeneous	Dark green, mottled	Dhahira
7	OMA 81	0.56	0.53	9.9	Heterogeneous	Dark green, brown, mottled	Dhahira
8	OMA 82	0.715	0.65	20.4	Homogeneous	Light green	Dhahira
9	OMA 96	0.645	0.585	16.3	Heterogeneous	Green, white cream, tan, pinkish	Dhahira
10	OMA 105	0.62	0.585	16.8	Heterogeneous	Pinkish, cream, green	Dhahira
11	OMA 118	0.575	0.54	14.5	Heterogeneous	White cream, tan, green, brown	Dhahira
12	OMA 123	0.59	0.55	14.8	Heterogeneous	White cream, tan, green, mottled	Dhahira
13	OMA 134	0.605	0.555	16	Heterogeneous	Green, light brown, tan, white cream, mottled	Batinah South
14	OMA 137	0.655	0.615	19.5	Heterogeneous	White cream, green	Batinah South
15	OMA 147	0.6	0.585	11.2	Heterogeneous	Light green, white cream	Batinah South
16	OMA 149	0.52	0.475	11	Heterogeneous	White cream, light green, dark brown, mottled	Batinah South
17	OMA 154	0.59	0.545	13.2	Heterogeneous	Dark blackish green, mottled light brown	Batinah South
18	OMA 159	0.605	0.56	11	Heterogeneous	Dark green, light green, brown, mottled	Batinah South
19	OMA 164	0.59	0.55	14.3	Heterogeneous	White cream, light green, dark green, tan, mottled	Batinah South
20	OMA 170	0.505	0.48	8.2	Heterogeneous	Dark green, dark brown, mottled	Batinah South
21	OMA 173	0.585	0.535	11.6	Homogeneous	Dark green, dark brown, mottled	Batinah South
22	OMA 178	0.51	0.49	7.9	Homogeneous	Brownish green mottled	Batinah South
23	OMA 181	0.55	0.535	9.9	Heterogeneous	Dark green, dark brown, mottled	Batinah South
24	OMA 185	0.65	0.64	17.8	Heterogeneous	White cream, light green, light brown, dark brown	Batinah South
25	OMA 198	0.59	0.525	14.6	Heterogeneous	Green, dark green, dark brown, tan, mottled	Batinah South
26	OMA 267	0.645	0.59	14.2	Heterogeneous	Pinkish brown, dark brown, black	Sharqiya
27	OMA 314	0.685	0.645	21.2	Homogeneous	Cream, light pink	Batinah North
Statistical Parameters							
Minimum		0.305	0.295	4.500			
Maximum		0.720	0.690	21.900			
Mean		0.597	0.548	14.104			
S.E.(±)		0.016	0.016	0.872			

3.2 Principal Component Analysis

In order to comprehend with which combination type of three seed characters the indigenous field pea germplasm of Oman would attain high quality in terms of their commercial value, the Principal Component Analysis was performed. The PCA transforms the number of associated traits into a smaller number of variables as PCs and simplifies the complex data. The Scree plot of the PCA (Figure 1) showed that the first two eigenvalues corresponded to the major proportion of the variance in the dataset.

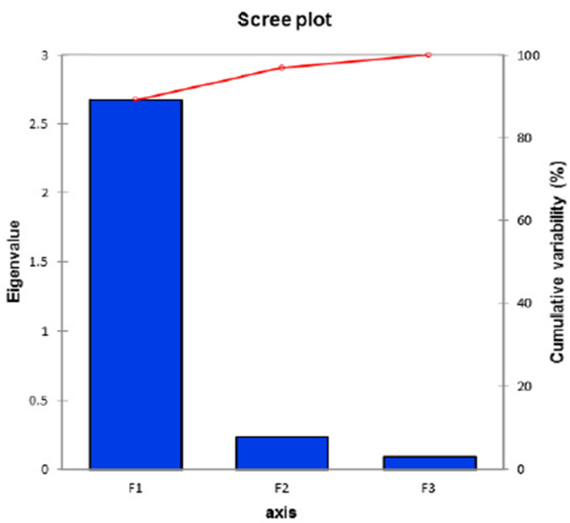

Figure 1. Scree plot showing eigenvalues in response to three principal components, PCAs or Factors (F1 to F3) for three seed variables/characters in field pea accessions

The first two PCAs extracted from the complicated components accounted to 96.915% with PC 1 having eigenvalue of 2.676 and PC 2, just 0.232 (Table 3). The first PC or factor accounts for maximum variability in the data in comparison with succeeding components or factors. The PCA grouped the estimated field pea variables into three main components of which PC 1 or factor 1 accounted for about 89.191% of the variation; PC 2 or factor 2 for 7.724% and PCA 3 or factor 3 for only 3.085% (Table 3).

Table 3. Eigen values and percent variance of principal components to total variation in indigenous field pea accessions

Principal Components (PC's) or Factors	Eigen value	% Variance	Cumulative variance
PC 1 or F1	2.676	89.191	89.191
PC 2 or F2	0.232	7.724	96.915
PC 3 or F3	0.095	3.085	100.000

The first PC was positively influenced by seed length with the value measuring 0.959 and 100-seed weight with 0.956 whereas the second PC was also influenced positively by seed width but with lower value (0.398). However, third PC was also associated with seed length which had low value (0.219) (Table 4). Similarly, only positive and significant correlation values (r) were found between three seed traits, studied viz. seed length vs seed width (0.806*), seed length vs 100-seed weight (0.907**) and seed width vs 100-seed weight (0.799*) (Table 5).

Table 4. The principal component values of three seed size characters in 27 indigenous field pea accessions

Variables/Characters	PC 1	PC 2	PC 3
Seed length (cm)	0.959	-0.180	0.219
Seed width (cm)	0.917	0.398	-0.008
100 Seed-Weight (g)	0.956	-0.202	-0.211

Table 5. Correlation coefficients between seed size characters of indigenous field pea accessions

	Seed length (cm)	Seed width (cm)	100 Seed-Weight (g)
Seed length (cm)	1	0.806*	0.907*
Seed width (cm)		1	0.799*
100 Seed-Weight (g)			1

In terms of per cent contribution of seed traits to the PCs, both seed length and 100-seed weight together contributed to the extent of 68.56% to PC1 and 99.92% to PC3 whereas seed width alone had 68.48% contribution to PC2 (Table 6).

Table 6. The percent contribution of variables (three seed size characters) to three principal component values in 27 indigenous field pea accessions

Variables/Characters	PC 1	PC 2	PC 3
Seed length (cm)	34.378	13.945	51.677
Seed width (cm)	31.440	68.485	0.075
100 Seed-Weight (g)	34.182	17.570	48.248

The scatter of 27 indigenous field pea accessions in biplot graph of the first two principal components as X and Y-axes clearly indicated that field pea accessions were clustered and occupied over all the four quadrants of the graph to classify the accessions into 10 clusters where the accessions belonging to the same group were closely positioned to form clusters in whichever quadrants of the graph they belonged due to their similarities (Figure 2). The number of accessions in the clusters ranged from single (Clusters V, VI, VII and X) to the highest of 5 (Cluster III and Cluster IX). The remaining 4 clusters had accessions ranging from 2 (Cluster I), 3 (Cluster IV) to 4 (Clusters II and VIII). The accessions of the clusters either belonged exclusively to the same governorates like Batinah South governorate (Cluster I) or to different governorates (Clusters II, III, IV, VIII and IX).

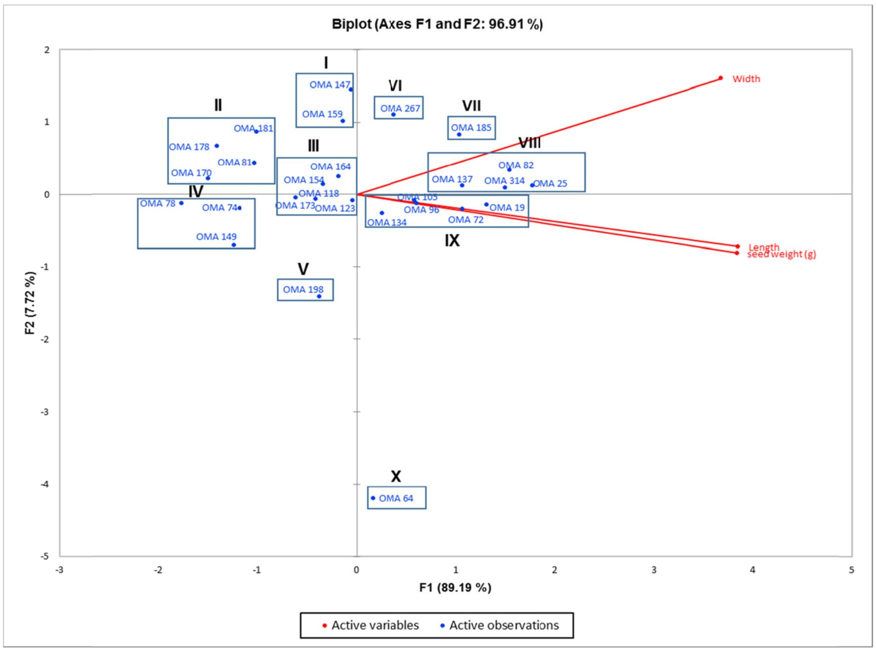

Figure 2. Principal component score of PC1 and PC2 describing the overall variation among indigenous field pea germplasm estimated using seed characters

4. Discussion

A range of field pea germplasm was collected during the collecting missions from the most governorates of the Sultanate. South Batinah-coastal governorate represented by Rustaq in the mountains contributed the highest proportions of accessions, collected (55.55%), followed by Dhahira & Buraimi governorates with 29.63% contribution. Governorates of Al-Dakhliyah (Interior) with two accessions accounted to 7.41% and Sharqiya-eastern area and North Batinah-coastal governorates with one each had the least of 3.70% contribution. Musandam governorate which is at Northern tip of the Sultanate had no contribution to collections during the collecting missions possibly because of farmers' switch over to greenhouse cultivation of vegetables due to irrigation water shortage in the area.

The critical examination of field pea seed samples at the laboratory showed large variation in seed coat patterns (color) and seed weights to such an extent that the villages located in the vicinity of collecting sites had either similar or different patterns of seed coat color in field pea seed samples/accessions. This indicated that there could be mixture of seeds between the land races during exchange or at harvest during cultivation (Al-Maamari et al., 2014). Seed accessions with heterogeneous seeds with respect to seed coat colors needed intensive purification into sub-groups (AlSaady et al., 2014).

The widespread transfer of landraces of field pea between wilayats and neighboring governorates of the Sultanate of Oman indicated that these landraces/accessions were the products of centuries of selection for adaptation to local climatic, edaphic and cultural factors thus possessing unique gene complexes that arise in the course of evolution (Mathur, 2010; Al-Maamari et al., 2014; AlSaady et al., 2014, 2018a, 2018b). Constant availability of landraces with the farmers having interest to stock with them for cultivation is an indication of existence of local conservation strategy for sustainable production (AlSaady et al., 2014). In the governorates like Al-Musandam where no field pea landraces were obtained and in Al-Dakhliyah, North Al-Batinah-coast and Sharqiyah where lower number of indigenous samples of field pea were found during present collecting missions than the collections made in other collecting missions in the past (Guarino, 1990) indicated the possibility genetic erosion of field pea germplasm. This is attributed to either replacement of landraces by modern high-yielding crops or changes in land use pattern, erratic drought or the lack of interest among current farmers to grow non-commercial crops like field peas.

The correlation analysis of seed characters showed their significant ($p < 0.05$) and positive associations between each other. Selection of strongly associated characters like seed length and 100-seed weight can be used to improve seed quality characters that influence yield and their value in marketing as suggested by earlier workers who studied both seed and yield traits in peas for selection of parents in crossing program (Singh & Srivastava, 2015; Ouafi et al., 2016; Bhuvaneswari et al., 2017; Iqbal et al., 2017).

The results of PCA analysis are useful to the breeders in identifying the phenotypic characters that contribute higher genetic variations among the genotypes for selection of potential parents for crossing to improve the traits of interest for productivity in quantity and quality (Kole et al., 2015; Khan et al., 2016). In the present study, PCA clearly indicated that all the seed traits contributed positively to PCA1 component reflecting the seed size potential of each genotype. Only seed width contributed positively to PCA2 in the present study. The existence of wider phenotypic variability among the indigenous field pea germplasm was further explained by the location pattern of different field pea landraces over all the four quadrants of the biplot graph. This provided an overview of the similarities and differences among the field pea accessions as well as of the interrelationships between the variables, studied. The graph characteristically demarcated the accessions about their scattering pattern based on the first two dimensions/components into 10 clusters based on seed characters in all the four quadrants, indicating wide genetic variability for the traits, studied. The accessions collected from the mountains of Al-Batinah South governorate such as OMA 198 from Alqoorah of wilayat Nakhal and OMA 64 from Haat of wilayat Rustaq were placed at extreme positions from the origin of the graph showing that they are genetically distinct accessions whereas other accessions were more concentrated around the origin of bi-plot graph, indicating their genetic similarity for the seed traits. The fact that accessions of certain clusters were similar or different in terms of their locations showed the extent of inter-exchange of the accessions occurred among the farmers from different governorates. It is advocated that the accessions of different clusters be utilized in crossing program for improvement of seed characters, as these accessions would be expectedly genetically distant.

5. Conclusions

27 field pea seed accessions collected during crop collecting missions were found to be spread over major parts of the country and were diverse with respect to seed related traits. These accessions were grouped into 10

genetically diverse clusters based on the Principal Component Analysis (PCA) using seed traits which revealed significant contribution of seed length (34.378%) and 100-seed weight (34.182%) to the total variation existing in indigenous field pea germplasm collected across all the governorates of Oman. The accessions of different clusters could be involved in crossing program for improvement of seed characters.

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