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Evaluation of genetic diversity of iranian turnip accessions (*Brassica rapa* L.) based on morphological characteristics

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Abstract

The current study, was educated for evaluation of genetic diversity of 11 Iranian turnip accessions with one British cultivar "Top Milan" cultivar, under field condition in Karaj. Twelve quantitative and Four qualitative traits were evaluated. Result revealed high variability among accessions. There were significant positive correlations between weight root and yield. Mean comparison of accessions showed that, Neyshaboor accession had the highest yield (2666.400 gr/m2) and weight root (177.760 gr) in compare with other accessions. In component analysis, five independent major factors explained 89.560 of total variance. based on cluster analysis Accessions were seprated into three groups. Morphological traits were useful for assessing the diversity and relationships in Iranian turnip accessions. In addition Accessions with desirable charachteristics can be identified to improve traits and use in breeding programs including increasing yield, improving agronomic charachteristics and improving quality.

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Introduction

The genus *Brssica* is one of the most economically important genera in the Family Brassicaceae (Rakow, 2004). This genus comprises a diverse group of species including major vegetable and oilseed crops with wide range of agronomic traits (Rich, 1991; Christopher *et al.*, 2005). It contains six economically important species with great genetic and morphological diversity which are cultivated worldwide (Saha *et al*, 2008). *Brassica* species play an important role in agriculture and horticulture, as well as contributing both to the economy and health of population around the world (King, 2005 ; Zhao, 2007).

Turnip (*Brassica rapa* L.) belongs to the Brassicaceae (Cruciferae) family, is wide spread in natural habitant from mediterian to central Asia as weed and probably was the first brassica domesticated to use its root, young flowering shoots and seeds by several civilizations (De Candolle, 1886;Hyams, 1971). It has a small, white fleshed root, often with the surface of the top half purpule and hairy leaves (Prince, 1987). Turnip roots are high in vitamin A, C, K and are a good source of potassium, calcium, phosphorus and magnesium (Heimler *et al.*, 2006). In addition it acts as an antibiotic (Hajisharifi, 2010).

Under various environmental conditions and altitudinal differences in Iran, there is great diversity between Iranian turnip accessions, that it has economic importance. Despite the custom use of molecular markers in the recent years, Morphological descriptor in genetic diversity analysis is still worthwhile (Mousavi *et al.*, 2012). In addition, morphological markers could greatly facilitate selections in breeding programs (Farsi and Zolali, 2003). Traditionally, morphological charachtristics are used to develop quantitative estimates of genetic similarities and relationships between the cultivate of relatives (Mac Key, 1988). The multivariate analysis and particular principal component and cluster analysis have been important strategies for, evaluation and classification of plant genetic resources especially when large numbers of accessions are to be assessed for several characters (Peeters and Martineelli, 1989).

This study was carried out to analysis the morphological variation in Iranian turnip accessions to derive their evolutionary relationships and qualitative and quantitative characteristics and commercially valuable between the accessions which used for breeding programs.

Materials and methods

The seeds of 11 Iranian turnip accessions were collected from throughout Iran and were planted with Top Milan cultivar as control in Karaj (51.10 East, 35.48 North and 1321 m Altitude). (Table 1).

Experiment was performed as a randomized complete block design (RCBD) with three replications. The seeds were planted on 3 meters long rows at the depth of 2 cm with an on-row spacing of 30 cm and inter row spacing of 40 cm in September 2013. Traits were measured using three random plants from each row. All accessions were observed during plants growth such as irrigation and manual weeding in order to have the plants with optimum growth for morphological study. The qualitative and quantitative traits of the accessions were measured based on descriptor (IBPGR, 1990). Based on Table 2 the quantitative characteristics consist of Leaf number, Leaf length (cm), Leaf width (cm), Petiole length (cm), Diameter of edible root (cm), Weight of edible root (gr), Main root length (cm), 1000 seed weight (gr), Dry weight percentage (%), root edible length (cm), seed diameter (mm) and yield (gr/m^2). Qualitative traits are 4 traits; seed color, anthocyanin, root color and root skin surface texture. Dry weight percentage was determined by oven drying at 60 ^{0}C for 48h. The analysis of variance was carried out by SAS Software. The mean were compared by Duncan Multiple range test and correlation and factory analysis were conducted by software SPSS. The clusters were analyzed by Ward method.

Table 1. Code, origin, center and geographical location of different Iranian turnip accessions.

Code	Accession collection	Province of Minute	longitude degree	minute	latitude degree		altitude (m)
1	Sabzevar	Khorasan razavi	21	59	10	36	999
2	Damghan	Khorasan razavi	12	54	6	36	1170
3	Mashhad	Khorasan razavi	43	57	12	36	978
4	Neyshaboor	Khorasan razavi	48	58	12	36	1250
5	Esfehan	Esfehan	39	51	37	32	1570
6	Kashan	Esfehan	27	51	59	32	984
7	Naien	Esfehan	05	53	51	32	1549
8	Mehriz	Yazd	31	54	36	31	1700
9	Dorang	Fars	32	52	37	29	1486
10	Karaj	Alborz	05	51	48	35	1300
11	Jiroft	Kerman	12	57	13	28	690

Table 2. Measured morphological traits in Iranian turnip accessions.

No	*Trait*	*Abbreviation sign*	*Unit*	*Measured method*
1	Leaf number	LN	-	Count
2	Leaf length	LL	cm	Ruler
3	Leaf width	LW	cm	Ruler
4	Petiole length	PL	cm	Ruler
5	Diameter of edible root	DR	cm	Caliper
6	Length of edible root	LR	cm	Ruler
7	Weight of edible root	WR	gr	Scale
8	Main root length	MRL	cm	Ruler
9	Dry weight percentage	DW	%	Scale
10	Seed diameter	SD	mm	Caliper
11	1000 seed weight	SW	gr	Scale
12	Yield	Y	gr/m^2	Count

Results and Discussion

Variance Analysis

The result of analysis of variance showed significant differences in all studied traits (Table 3), that illustrated; there is considerable genotypic and morphologically variation in Iranian turnip accessions. The result have conformity with (Lou *et al.*, 2007 and Amirian *et al.*, 2011).

Mean Comparison

Based on Table 4 mean comparison of accessions showed that, Neyshaboor with (177.760gr) (2666.440gr/m^2) and Jiroft accession with (166.340gr) (2450.234gr/m^2) had the highest average of edible root weight and yield, it means that, Jiroft and Neyshaboor accessions despite of different geographical origin could adopted themselves. Top Milan cultivar as a control was 5th in this grouping; (118.223gr) (1777.301gr/m^2). Mehriz accession had lowest average of edible root (898.5gr/m^2), it is due to, Mehriz accession with Warm geographical origin could not adopt with cold climate in Karaj, then it is not suggested in climate condition of Karaj (51.10 East, 35.48 North and 1321 m Altitude). Top Milan cultivar had the highest average of 1000 seed weight and seed diameter, respectively (1.243gr) and (0.421mm) that is more preferred for seed production by economic market, and maybe because of this,

farmers preferred cultivated Top Milan cultivar in Karaj. but (Amirian *et el.*, 2010) resulted, Khosf accession with highest 1000 seed weight was recommendable for seed production in Warm-Dry Yazd climate condition. In this study the highest and lowest average of leaf number respectively belonged to Jiroft (20.667) and Esfahan (6.666) accessions.

Table 3. Analysis of variance of morphological traits in Iranian turnip accessions.

Source of variation	Mean square					
	LN	LL	LW	PL	DR	LR
Replication	0.830^{ns}	0.078^{ns}	0.169^{ns}	4.652^{ns}	3.97*	0.504^{ns}
Accession	39.946**	51.944**	13.426**	54.132**	17.810**	46.007**
Error	1.598	1.520	0.54	5.306	1.01	0.227
CV%	10.760	5.583	8.859	16.212	7.146	5.977

Continue of Table 3. Analysis of variance of morphological traits in Iranian turnip accessions

Source of variation	Mean square					
	WR	MRL	DW	SD	SW	Y
Replication	145.695^{ns}	600.000^{ns}	0.209^{ns}	0.003^{ns}	0.000^{ns}	188843.620^{ns}
Accession	4717.303**	37.597**	23.134**	0. 033**	0.021**	1061432.630**
Error	209.939	817.000	0.328	0.000	0.000	48498.530
CV%	10.760	5.583	8.859	1.603	2.548	13.001

ns,*, ** respectively non significant, significant difference at 5% and 1% probability levels.

Table 4. Mean comparison of morphological traits in Iranian turnip accessions.

Code	*LN*	*LL*	*LW*	*PL*	*DR*	*LR*
1	9.666d	20.993c	6.853de	12.433cd	14.906bcde	6.583cd
2	11.000cd	18.830c	6.890de	21.066ab	16.583ab	6.183de
3	9.666d	22.130bc	8.706cd	10.160d	14.380be	7.920bc
4	10.000cd	20.673c	6.716de	9.993d	10.766f	4.720ef
5	6.666e	11.963d	6.430e	14.633bd	12.460def	16.210a
6	10.000cd	19.696c	6.620de	14.533bd	10.430f	6.110de
7	13.333bc	27.010	6.310e	14.500bd	11.646ef	5.086ef
8	12.333bd	25.233ab	9.263bc	9.920d	15.810ac	6.786bd
9	15.333bc	26.176a	9.806bc	22.080a	a.467ad	8.200b
10	9.666d	25.286ab	7.940cb	14.423bd	15.066ad	4.293f
11	20.667a	24.800ab	11.360ab	17.380ac	18.333a	8.040bc
12	13.333bc	22.080bc	12.716a	0.380d	12.890cf	15.610a

Means with similar letters in each column are not significant different at 1% probability level.

Continue of Table 4. Mean comparison of morphological traits in Iranian turnip accessions.

Code	*WR*	*MRL*	*DW*	*SD*	*SW*	*Y*
1	74.866ef	14.573b	9.263cd	1.0367e	0.250de	1123.000ef
2	112.78be	6.673e	10.126cd	1.133bc	0.306c	1691.600be
3	146.070ac	12.083bc	7.133e	1.130cd	0.267d	2191.000ac
4	177.76a	11.206cd	12.420ab	1.080ce	0.224f	2.666.400a
5	109.48ce	10.650cd	8.843d	0.950f	0.192g	16421.1ce
6	74.730ef	9.986ce	10.623c	1.200ab	0.416a	1121.000ef
7	82.983df	10.930cd	13.560a	1.063de	0.231ef	1244.800df
8	59.900f	10.310cd	10.336cd	1.063de	0.224g	898.501f
9	80.333df	10.310cd	4.513f	0.850g	0.165h	1205df
10	74.730ef	8.810de	9.680cd	1.110cd	0.332b	2318.700ab
11	154.580ab	7.536e	10.903bc	1.143bc	0.325bc	2450.200a
12	163.340a	20.726	4.513f	1.243bc	0.421a	1774.301bd

Means with similar letters in each column are not significant different at 1% probability level.

LN=leaf number, LL=leaf length, LW= leaf width, PL= petiole length, DR=diameter of root, LR= length of root, WR= weight of root, MRL= main root length, DW= dry weight, SD= seed diameter, SW=1000 seed weight, Y=yield

Correlation Coefficients

Correlation coefficients of morphological traits of Iranian turnip accessions showed that leaf length and leaf width had positive correlation with leaf number (0.626*, 0.660*), in addition yield and leaf number had positive correlation with each other (0.653*); that maybe it because of, photosynthesis impact of nutrition value that is leading to more yield. Seed diameter had significant correlation with 1000 seed weight (0.872**) and it because of the proportion of seed diameter of seed weight. Finally yield and edible root weight had significant correlation with each other (1.000**); that shows the proportion of root index of yield (Table 5). Bagheri *et al* (2010), evaluated 17 traits in *Brassica rapa*, their study revealed that between leaf number with stem thickness, flowering time, branch number until first flowering was positive significant correlation.

Table 5. Correlation coefficients calculated from the morphological Traits for 12 turnip accessions.

	LN	*LL*	*LW*	*PL*	*DR*	*LR*	*WR*	*MRL*	*DW*	*SD*	*SW*	*Y*
LN	-											
LL	0.623 *	-										
LW	0.660 *	0.391	-									
PL	0.356	0.050	_0.081	-								
DR	0.533	0.311	0.455	0.429	-							
LR	_0.080	_0.534	0.413	_0.139	_0.083	-						
WR	_0.024	_0.052	0.140	_0.149	0.061	_0.609	-					
MRL	_0.131	_0.056	0.407	_0.579	_0.336	0.539	_0.122	-				
DW	_0.035	_0.036	_0.609	_0.08	0.207	_0.586	0.096	0.553	-			
SD	0.062	0.020	0.253	_0.142	_0.112	_0.138	0.283	0.269	0.154	-		
SW	0.106	_0.027	0.308	0.137	_0.109	0.083	0.197	0.281	_0.092	0.872**	-	
Y	0.653 *	0.052	0.140	_0.149	0.061	0.068	1.000**	_0.131	_0.096	0.283	0.197	-

Principle Component Analysis

Principle component analysis (Table 6) was done to determine the role of each studied traits. The result showed that traits classified into five factors, which had 89.560 of the variety between the accessions. In the second factor, the most effective traits were those traits related to leaf index (leaf number, leaf length, leaf width). in the third factor, the most effective traits were those which, related to edible root and yield, and finally the fifth factor, effective traits related to seed index (seed diameter, seed weight). As it was illustrated in Table 6, the traits in third factor, was very influential on crop yield which had the highest contribution in relative variance (24.351%)

Table 6. Principal component analysis of morphological traits in different Iranian turnip accessions.

	Components				
Parameter	1	2	3	4	5
LN	0.109	0.883*	_0.014	_0.165	0.008
LL	_0.049	0.690*	0.096	_0.489	_0.447
LW	0.694*	0.640*	_0.250	0.041	_0.111
PL	_0.504	_0.491	_0.151	_0.263	0.529*
DR	_0.078	0.791*	_0.070	0.230	0.136
LR	0.539*	_0.210	_0.570	0.423	0.156
WR	0.337	0.094	0.741*	0.540*	_0.176
MRL	0.732*	_0.228	_0.416	_0.179	_0.282
DW	_0.496	_0.186	0.624*	_0.328	0.008
SD	0.659	_0.058	0.489	_0.427	0.314*
SW	0.672	0.014	0.307	_0.336	0.540*
Y	0.337	0.094	0.741*	0.541*	_0.167

Components	Eigen value	Relative value%	Cumulative valiance%
1	2.744	22.531	24.513
2	2.215	22.627	47.158
3	2.942	24.351	67.509
4	1.586	13.216	80.724
5	1.060	8.836	89.560

LN=leaf number, LL=leaf length, LW= leaf width, PL= petiole length, DR=diameter of root, LR= length of root, WR= weight of root, MRL= main root length, DW= dry weight, SD= seed diameter, SW=1000 seed weight, Y=yield

Cluster Analysis

Cluster analysis was done based on Ward method (Table 7) (Fig.1). Accessions classified in three separated groups, the result showed, the first group consist of Sabzevar, Kashan, Naien, Mehriz and Dorang that had the highest average of leaf index (leaf number, leaf length, leaf width) and lowest yield in compare with other groups. The second group was Esfehan, Damghan accessions and Top Milan cultivar that had the highest average of seed index (seed diameter, seed weight). The last group consists of Mashhad, Jiroft, Neyshaboor and Karaj, that the most important index of this group was their high average of edible root weight and yield in comparison of other groups. The study of the cluster analysis showed that, despite of same geographical places in some accessions based on Table 1, they were not derived in the same cluster , in other hand, despite of the great differences between the studied traits, after grouping, the sample with similar characteristics collected from various regions, stood in one group. In addition to create high quality hybrids, it is better to select the greatest distance in cluster analysis considering their characteristics. The genotypes of the groups with valuable traits could be used in breeding programs. (Amirian *et al*,. 2010) reported that turnip accessions were grouped in Seven clusters in distance of 10 from 25.

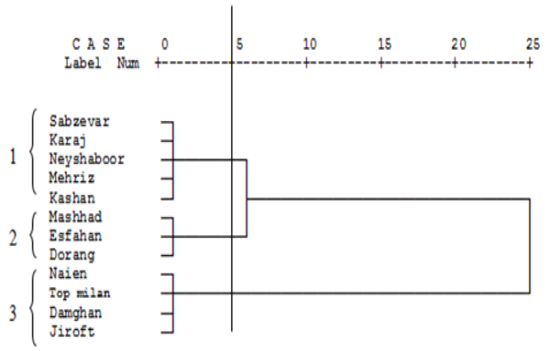

Fig 1. Dendrogram of cluster analysis of Iranian turnip accessions by WARD'S method

Table 7. Mean of morphological traits of different groups, derive from cluster analysis in Iranian turnip accessions.

Parameter	*1*	*2*	*3*	*Total mean*
LN	12.140	10.340	12.340	11.666
LL	23.830	17.632	23.231	21.56
LW	7.770	8.681	8.681	8.388
PL	14.701	15.032	12.994	14.244
DR	13.662	13.980	14.640	14.090
LR	6.562	12.670	6.251	8.492
WR	74.571	113.501	150.444	116.171
MRL	11.230	13.031	9.920	11.290
DW	9.663	7.833	10.041	9.180
SD	1.050	1.113	1.121	1.092
SW	0.261	0.310	0.291	0.280
Y	1118.441	1702.700	2406.570	1742.576

Qualitative Analysis

The evaluation of qualitative characteristics, Iranian turnip accessions and Top Milan cultivar, showed, five color (very dark brown, dark brown, light brown, dark red, light red) in seed color, while (Bagheri *et al.*, 2010) reported that seed color in inbreed line population of *Brassica rapa* was ranked into nine different classes (from yellow to black). In this study, Neyshaboor was the only accession that surface of its root was coarse. Despite of high yield of Neyshaboor accession, unpopularity of produce of this accession in Iran is due to its undesirable appearance. five color of roots (white, white purple, mixed color, dark purple) was observed, that have conformity with (Amirian *et al.*, 2010). Bicolor edible root in Turnip, because of existence of Anthocyanin is valuable trait that is more preferred by market.

Table 8. Description of qualitative morphological traits in Iranian turnip accessions.

code	*Seed color*	*Root surface*	*Root color*	*Anthocyanin*
Sabzevar	light brown	smooth	white	-
Damghan	light red	intermediate	white-purple	+
Mashhad	dark red	smooth	mixed color	+
Neyshaboor	light red	coarse	white	-
Esfehan	light red	intermediate	withe	-
Kashan	light brown	smooth	white purple	+
Naein	light brown	smooth	white	-
Mehriz	light brown	intermediate	mixed color	+
Dorang	dark brown	intermediate	with purple	+
Karaj	dark brown	intermediate	dark purple	+
Jiroft	dark red	smooth	white purple	+
Top Milan	very dark brown	smooth	white purple	+

Conclusion

as an conclusion, this study showed that, Iranian turnip accessions have high morphological genetic diversity. this provides efficient germoplasm for breeding goals, especially for releasing of varieties with high adaption to Iran climate. In addition Jiroft accession with relative high yield, medical value due to existence of Anthocyanin and desirable appearance, is proper accession that can be cultivated in cold semi-arid Karaj climate condition (51.10 East, 35.48 North and 1321 m Altitude). (Table 1).

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