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Evaluation of Iranian Oilseed Rape Germplasm Collection

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Abstract:
With the aim of evaluation and characterization of important agronomical, morphological and qualitative traits of canola germplasm, 14 and 30 accessions of canola were planted in two separate randomized complete block designs with 3 and 2 replications respectively, at the Seed and Plant Improvement Institute (SPII), Karaj-Iran during 2006-2007. For both experiments, all important agronomical and phenological traits including number of days to flowering initiation, number of days to end flowering, number of branches/plant, plant height, number of grain/pod, number of pods on main stem, number of pods on plant, main pod length, secondary pod length and maturity time were recorded during growth period. At ripening, biological and grain yield, harvest index, 1000 grains weight, oil content and oil yield for each genotype were calculated. Based on the analysis of variance and means comparison results the genotypes had highly significant differences in most of the studied traits. Classification of genotypes using Ward's minimum variance method based on squared Euclidean distance measure resulted in five separate and distinct groups which could be clearly distinguished based on some traits. It could be concluded that there is a broad genetic diversity in the germplasm collection of rapeseed which could be utilized in breeding programs.

***Key words**: canola, genetic diversity, germplasm collection, morphological traits*

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1. INTRODUCTON

The *Brassicaceae* family consists of many important field crops and vegetables such as oilseed rape. The rapeseed rank third in the world and is most important vegetable oil source with an annual growth rate exceeding that of palm. Rapeseed is also the world's second leading source of protein meals. The main rapeseed producing regions of the world are China, Canada, India and northern Europe. Worldwide production of rapeseed has increased six fold between 1975 and 2007 using conventional and modern plant breeding approaches. World production is expected to incrase further upward over between 2005 and 2015 [6].

Genetic diversity is of prime importance for the improvement of many crop species including *Brassica* [14]. Evaluation of genetic diversity among wild and crop plants population is necessary for protection, conservation and useful application of germplasms, identification of suitable parents for high quality crosses and identification of genetic content for important breeding traits[10, 3, 4, 2]. On the other hand, low levels of genetic diversity in studied cultivars increase the potential vulnerability to diseases and pests [9].

Forty-six germplasm lines were evaluated for grain yield and its components, separately under protected (chemical control against pest and disease) and unprotected conditions using RBD design with two replication each to investigate powdery mildew reaction, aphid resistance during *rabi* season of 2007-08 at RARS, Bijapur [7]. Grain yield per area and grain yield/plant showed highest phenotypic and genotypic coefficient of variation under both protected and unprotected conditions followed by biological yield/plant. Heritability in broad sense and GAM were higher for grain yield per meter followed by number of silique/plant, number of grains per silique under both conditions suggesting less influence of environment in these characteristics. Rashidifar *et al.* (2010) studied the genetic diversity of 39 winter oilseed rape cultivars at Karaj-Iran and classified them in to 4 separate and distinct groups thorough Cluster analysis using Ward's minimum variance method based on squared Euclidean distance . In another experiment, 24 spring rapeseed cultivars were compared in a Randomized Complete Block Design with four replications over two years period (2001- 2002) in Jiroft, a warm climate in the south of Iran. Simple and combined variance analysis of two years data showed that these cultivars were significantly different (P=0.01) in number of pods per plant, number of grains per pod, 1000 grain weight and oil percentage. Means comparison showed that cultivar Sarigol had the maximum number of pods per plant compared to Option500 and Hyola308. Cultivar Hyola308 was superior to other cultivars based on number of grain per plant (23.8) followed by Hyola401, Option500 and Hyola420, respectively. The maximum grain yield was obtained from Hyola420 and Hyola308 cultivars with 4186 and 4012 kg/ha, respectively [11]. Fanaii *et al.* (2010) assessed the yield, yield components and some agronomic traits of 18 spring genotypes of rapeseed in the condition of Sistan region of Iran during two years. Compound analysis of variances showed that the genotype had significance effect ($p<0.01$) on number silique in plant, number of grains per silique, height, grain yield and oil percent. The highest grain yield (4484, 4370 and 4153 kg/ha) obtained from Syn-3, Hyola401 and Hyola420 hybrids and lowest grain yield (2742, 3126 and 3221 kg/ha) was obtained from option500, Cracker Jack and Heros, respectively. Genotype Option500 with 48.2 percent of oil and Hyola401 with 1969 kg/ha oil yield had the most amount of oil percent and respectively. It could be recommended that hybrids Hyola401 and Hyola420 were more suitable than open pollination genotypes for Sistan region of Iran [5].

The principal aim of this research was to characterize and grouping of oilseed rape collection in the oilseeds research department of Iran to use them in breeding programs and minimize the number of cross-combination.

2. MATERIALS and METHODS

Forty four genotypes of oilseed rape collection were evaluated in two separate randomized complete block designs with different replications because of shortage of seed for some genotypes. The experiments were conducted in the research nursery of Seed and Plant Improvement Institute (SPII), Karaj, Iran during 2006-2007. Seeds of each genotype were sown in four rows four meters long on 60 cm furrow system (two rows in each furrow thus 30 cm spacing between two rows). Nitrogen fertilizer in the form of urea (46 % N) was applied uniformly on all plots (50 kg N ha^{-1} at sowing, 50 kg N ha^{-1} top-dressed at the start of flowering and 50 kg N ha^{-1} top-dressed at the start of budding). Other fertilizers were applied prior to plowing at the recommended rates of

59 and 100 kg ha^{-1} for P_2O_5 and K_2O, respectively. A sample of five representative plants was taken from each plot for recording data on plant characteristics.

In both experiments, all important agronomical and phenological traits including days to flowering initiation, end of flowering, number of branches/plant, plant height, number of grains/silique, number of siliques/main stem, number of siliques/plant, main silique length, secondary silique length and maturity time were recorded during growth period. At ripening, biological and grain yield, harvest indices, weight of 1000 grains, oil content and oil yield for each genotype were calculated.

The two experiments were subjected to combined analysis of variance and means of genotypes for all traits were compared using LSD [13]. With the purpose of classification of genotypes, squared Euclidean distance and Ward's minimum variance method of clustering were used [12].

3. RESULTS and DISCUSSION

According to the combined analysis of variance, there were significant differences ($p<0.01$) among oilseed rape cultivar collections based on all traits except biological yield (Table 1). This great genetic difference among the studied genotypes offers a valuable opportunity for implementing this variation in breeding programs.

The traits such as main and secondary siliques length, number of days to start and end of flowering, number of grains per main siliques, main silique length and oil content had the highest values of broad sense heritability (over 50%) and indicated that genetic agents mainly controlled the variation of these traits (Table 1).

The mode of gene action and importance of additive versus non-additive portion of variability remains to be surveyed. In contrast, the traits including first branch height, number of siliques/main stem, first silique height and biological yield had the lowest heritability (Table 1) and it could be concluded that these traits are most prone to environmental variations.

Table 1. Combined analysis of variance (Mean Squares) phenological and morphological traits of 44 genotypes of oilseed rape

Traits	S.O.V (df)				C.V.	$V_{(g)}$	$C.V._{(g)}$	h^2
	Set (1)	Replication /Set(3)	Genotype /Set(42)	Error (55)				
Days to flowering	2.44	3.285	25.59 **	3.027	0.93	9.03	1.61	74.88
Days to end flowering	52.63	1.704	98.21 **	17.28	1.87	32.37	2.56	65.20
Flowering duration	32.40	9.35	38.59 **	14.35	10.69	9.70	8.79	40.32
Plant height	949.8 **	103.03	183.43 **	79.94	10.66	41.40	7.67	34.12
Stem diameter	7.85 **	0.78	0.98 **	0.47	9.91	0.20	6.53	30.27
Number of branches	5.82 **	0.53	1.15 **	0.46	13.73	0.28	10.64	37.50
Number of siliques/main stem	785.29 **	100.2 *	69.15 *	35.96	22.39	13.28	13.60	26.96
Number of siliques/branches	2876.9	774.5	1696.2 **	769.2	28.02	370.80	19.45	32.53
Number of siliques/plant	6668.3 **	1213.13	2005.27 **	813.53	22.68	476.70	17.36	36.95
Main stem length	140.68 *	51.79	81.99 **	20.69	12.37	24.52	13.47	54.24
No. of grains/main siliques	228309.8 **	35.78	285.65 **	50.30	8.82	94.14	12.07	65.18
No. of grains/secondary siliques	237322.7 **	148.44	320.09 **	104.97	12.68	86.05	11.48	45.05
Main siliques length	0.3305 *	0.1022	0.739 **	0.0586	3.95	0.27	8.51	82.28
Secondary siliques length	0.6369 **	0.0428	0.525 **	0.0316	3.07	0.20	7.67	86.20
First silique height	299.86 **	17.53	74.711 *	41.871	12.16	13.14	6.81	23.88
First branch height	150.49 *	28.93	57.76 **	28.47	30.07	11.72	19.29	29.15
1000 grain weight	0.037	0.0339	0.1956 **	0.0734	7.49	0.05	6.11	39.97
Oil percent	5.172	3.695	7.488 **	2.013	3.34	2.19	3.48	52.11
Biological yield	5.92	15.0 *	6.56	4.215	26.2	0.94	12.36	18.20
Grain yield	0.694 *	1.137 **	0.543 **	0.167	29.4	0.15	27.90	47.39
Harvest Index	22.66	14.33	31.12 **	9.109	17.4	8.80	17.11	49.15
Oil yield	0.151 *	0.222 **	0.107 **	0.033	30.9	0.03	29.26	47.28

* and ** significant at 5% and 1% probability levels, respectively

3.1. Mean Comparisons

The results of mean comparisons are shown in table 2. The results clearly show that there are significant differences among genotypes which could be incorporated in breeding programs to improve the grain and oil yield.

3.2. Cluster Analysis

Cluster analysis using Ward's minimum variance method based on squared Euclidean distance measure grouped 44 genotypes into five distinct clusters (Figure 1). The first group composed of Star, KN6, Mozart and Ryder which were early ripening genotypes and had also high performance capacities. The second cluster composed of Fr1, Fr2, Fr5, Parade, KN2, Hopper, VDH 800, Dexter, Orkan, Fr3, Calibra, OR2-81 and Wotan which had higher values of plant height, stem diameter, number of grains per silique and number of siliques per plant (Figure 5).

The genotype KN1 made the 3rd group itself and was apparently distinct from other genotypes having early maturity and higher plant height, more branches and siliques per plant and low silique length, number of grains per silique and 1000 grain weight.

Table 2. Means of oilseed rape genotypes for the traits under study in the experiment

Traits / Genotypes	Star	Dexter	Fr 1	Fr 2	Fr 3	Fr 5	Hopper	KN1	KN2	Option 501	Orkan	Parade	Ryder	VDH 8003/98	LSD5%
Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
Days to flowering	184	189	189.33	187	186	184.67	186.67	179	191	181.67	184.33	190.67	188.67	188.33	3.732
Days to end flowering	211.67	223.67	224	223	219.67	222	223.33	213	228.67	208.33	222.67	228.33	220.33	228	6.592
Flowering duration	27.67	34.67	34.67	36	33.67	37.33	36.67	34	37.67	26.67	38.33	37.67	31.67	39.67	6.097
Plant height	90.8	84.32	87.83	88.3	85.6	77.93	92.67	94.67	99.19	66.3	85.57	84.77	96.37	90.87	16.83
Stem diameter	6.9	7.48	7.19	7.64	7.74	7.19	7.4	6.89	7.85	5.42	7.43	7.26	8.26	6.75	1.31
Number of branches	5.33	4.72	4.73	4.2	6.0	4.73	5.23	7.73	4.48	5.29	5.0	4.57	6.03	4.82	1.352
Number of siliques/main stem	32.17	27.83	24.5	27.7	25.8	23.47	33.9	33	34.85	26.2	29.73	26.63	39.87	35.63	10.705
Number of siliques/branches	77	128.6	104.7	99.1	101.7	84.4	85.39	188.4	100.8	72	134.1	69.87	111.3	117.1	50.28
Number of siliques/plant	109.17	156.41	129.23	126.8	127.53	107.87	119.29	221.37	135.65	98.2	163.8	96.5	151.2	152.73	51.2
Main stem length	35.13	39.91	38.43	39.43	32.33	32.07	44.1	35.77	42.92	30.71	38.2	38.87	43.53	43.13	7.91
No. of grains/main siliques	22.32	25.47	23.78	22.65	25.3	27.51	26.49	15.77	22.25	22.15	26.87	26.44	24.11	22.94	4.36
No. of grains/secondary siliques	20.27	22.47	23.21	22.53	25.9	26.1	21.23	17.69	23.05	24.14	24.71	26.46	22.67	23.49	3.861
Main siliques length	5.84	6.43	5.69	6.19	6.44	6.47	6.05	4.3	6.07	5.74	6.78	5.88	6.92	6.1	0.443
Secondary siliques length	5.43	5.89	5.38	5.81	6.12	5.93	5.39	4.25	5.91	5.87	6.05	5.85	6.06	5.91	0.32
First silique height	58.7	52.43	57.13	58.53	58.4	54.37	54.23	64.27	62.25	39.36	52.27	54.37	57.67	49.6	12.89
First branch height	23.97	13.94	18.93	21.77	18.47	18.73	18.17	23	35.27	13.28	13.9	18.73	15.63	14.99	7.813
1000 grain weight	4.24	3.73	3.49	3.72	3.61	3.96	3.53	2.81	3.43	3.57	3.85	3.59	3.67	3.7	0.536
Oil percent	45.17	43.04	40.8	40.52	45.1	42.26	43.14	42.66	43.38	46.03	42.1	40.73	43.4	40.1	2.519
Biological yield	7.89	7.11	8.22	8.89	8.44	8.33	8.33	7.78	8.0	5.0	8.0	6.56	11.44	10.22	4.136
Grain yield	1.63	1.26	1.25	1.43	1.59	1.34	1.73	1.23	1.06	1.09	1.59	0.71	2.94	1.91	0.783
Harvest Index	20.37	16.32	15.67	15.91	18.9	15.6	21.78	15.87	12.69	21.89	19.96	10.72	26.24	18.87	6.113
Oil yield	0.74	0.54	0.51	0.58	0.72	0.57	0.75	0.52	0.46	0.5	0.68	0.29	1.28	0.77	0.351

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Table 2. Continued

Traits / Genotypes	Akamar	Aviso	Banjo	Boomerang	Calibra	Ceres	Cheyenne	CV Roby	Embleme	Fr 4	Fr 6	Herald	KN3	KN5	KN6
Number	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
Days to flowering	188.5	189.5	188	189	187.5	187	189.5	189.5	189.5	186	184.5	189	188	181.5	181.5
Days to end flowering	228	228	224.5	227	222	227	232.5	231	222.5	224.5	224.5	226	225.5	214	207.5
Flowering duration	39.5	38.5	36.5	38	34.5	40	43	41.5	33	38.5	40	37	37.5	32.5	26
Plant height	77.5	80.45	84.05	78.65	96.3	87.6	75.35	87.3	84.95	70.8	70.6	89.6	82.3	76.8	84.05
Stem diameter	7.31	6.8	6.21	7.05	7.55	7.06	7.01	6.27	6.77	6.84	6.23	7.36	6.76	5.86	6.74
Number of branches	4.75	4.5	3.5	5.4	5.15	4.7	4	5.25	4.85	5.15	4.1	3.8	4.35	4.75	5.4
Number of siliques/main stem	22.65	20.45	22.7	23.25	34.45	22.35	15.4	32.75	20.75	21.45	19.25	30.15	19.5	23.15	31.9
Number of siliques/branches	131.5	107.2	62.15	140.5	109.75	81.85	88.45	79.35	100.7	94.55	73.2	78.65	81.2	72.4	74.7
Number of siliques/plant	154.15	127.65	84.85	163.75	144.2	104.2	103.85	112.1	121.45	116	92.45	108.8	100.7	95.55	106.6
Main stem length	35.25	30.15	41.8	34.3	47.65	40.65	27.6	42.9	35.9	28.2	31.35	45.85	38	29.6	27.2
No. of grains/main siliques	124.3	130.05	133.2	122.75	137.8	121.3	119.1	135.6	122.15	113	121.95	144.35	134.05	111.7	101.6
No. of grains/secondary siliques	118.95	131.15	137.2	125.05	125.85	121.75	144.3	120.45	126.95	136.15	117.95	146.05	135.1	112.4	92.8
Main siliques length	7.12	6.33	6.67	5.85	7.3	6.31	6.39	6.09	6.43	6.24	6.21	6.15	6.66	5.57	5.49
Secondary siliques length	6.62	6.12	6.13	5.41	6.69	5.71	6.48	5.83	6.37	6.1	5.69	6.13	6.07	5.51	5.2
First silique height	48.25	59.2	46.85	48.55	55.15	52.75	55.55	54.1	58.8	48	48.5	49.8	50.9	51.65	59.6
First branch height	13.85	15.95	15.95	8.5	13.2	19.55	22.05	16.6	21.85	14.5	16.3	18.6	13.7	20.5	25.45
1000 grain weight	3.36	3.32	3.61	3.01	3.58	3.59	3.38	3.39	4.05	3.57	4.05	3.47	3.45	3.78	4.11
Oil percent	40.21	40.38	41.29	41.38	41.58	40.99	41.4	41.46	42.72	42.47	41.98	40.56	42.2	43.93	45.58
Biological yield	7.9	8.0	10.87	5.78	6.41	7.4	6.8	4.4	7.8	5.53	5.3	7.6	9.6	8.0	10.4
Grain yield	1.22	0.98	2.15	1.02	1.23	0.84	0.88	0.42	1.37	0.98	0.91	1.43	1.37	1.58	2.24
Harvest Index	15.14	12.25	19.74	17.43	18.69	11.34	12.72	9.52	17.5	17.8	17.12	18.83	14.34	19.75	21.62
Oil yield	0.5	0.4	0.89	0.42	0.52	0.34	0.36	0.17	0.59	0.42	0.38	0.58	0.58	0.7	1.02

Table 2. Continued

Traits / Genotypes / Number	Milena	Mozart	NSA-2	Olga	Olpro	OR2-8199	PAUC 906	Sinatra	SW 5001	Talent	Turner	Ural	Valesca	VDH 8001/97	Wotan	LSD5%
Number	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	
Days to flowering	186	186	179.5	185.5	191	185.5	189.5	189.5	182.5	187.5	186.5	178.5	191	188	188	2.62
Days to end flowering	221	217	202.5	222.5	225	220.5	226	227.5	216	226.5	222.5	213.5	231.5	221	222	8.432
Flowering duration	35	31	23	37	34	35	36.5	38	33.5	39	36	35	40.5	33	34	7.6
Plant height	86.35	84.85	60.95	76.8	79	96.8	77	92.55	63.95	83.4	74.7	68.9	79.28	86.5	102	15.99
Stem diameter	7.21	6.52	4.86	6.06	6.38	8.05	6.99	6.5	5.32	7.28	6.38	6.38	6.67	6.98	6.91	1.202
Number of branches	3.95	4.95	4.3	5.65	5.1	5.45	4.15	4.85	5.3	4.95	4.45	4.35	4.84	4.75	4.9	1.13
Number of siliques/main stem	22.65	35.35	17.2	28.25	21.5	37.84	16.75	24.25	23.65	22.6	19.95	21.1	24.51	24.7	33.15	11.25
Number of siliques/branches	77.8	103.3	56.05	113.2	85.3	129.8	77.9	107	85.7	121.1	79.75	57.1	110.1	106.9	148.8	51.36
Number of siliques/plant	100.45	139	73.3	141.4	106.8	167.7	94.65	131.3	109.4	143.7	99.7	78.2	134.6	132	182	53.3
Main stem length	35.75	40	24.5	35.9	29.8	50.3	35.3	39.1	29.1	36	29.3	32.6	34.8	35.9	49.4	8.7
No. of grains/main siliques	134.45	103	91.1	98.8	129.4	123.6	127.4	109	94.45	134.1	98.75	109.9	122.09	116.7	134.6	17.39
No. of grains/secondary siliques	119.1	97.8	102.8	93.85	127.8	116.8	152.9	134.9	98.9	123.3	117.3	114.1	122.7	110	110	25.6
Main siliques length	6.55	5.8	5.65	5.46	6.67	6.34	5.87	6.12	5.29	6.85	5.44	5.49	6.64	6.5	5.9	0.44
Secondary siliques length	5.92	5.22	5.65	5.46	6.6	5.9	5.29	5.84	5.25	6.44	5.13	5.37	6.45	5.83	5.57	0.33
First silique height	55.85	47.75	43.8	45.55	58.05	53.34	49.1	59.9	39.9	52.75	51.85	41.1	51.54	55.45	59.55	10.87
First branch height	23.05	16	15.7	11.5	22.7	11.7	8.5	21.6	10.6	15.4	19	14.2	21.9	14.1	19.6	11.3
1000 grain weight	3.73	3.43	3.38	3.31	3.59	3.85	3.66	3.47	3.74	3.97	3.61	3.46	3.17	4	3.8	0.46
Oil percent	44.06	45.7	45.9	43.8	41.3	42.4	38.9	43	44.5	42.9	40.3	44.1	41.3	40.1	42.2	2.67
Biological yield	10	9.4	4	6.8	8.9	5.9	8.6	9.2	8	10	8.6	7.2	5.6	9.2	6.8	3.44
Grain yield	2.06	2.25	0.8	1.11	1.56	0.84	1.62	1.38	1.73	1.2	1.27	1.34	0.8	1.6	1.2	0.72
Harvest Index	20.6	23.8	20	16.9	17.3	15.1	18.8	14.9	21.6	11.8	13.9	18.6	14.2	18.6	18.6	4.96
Oil yield	0.91	1.03	0.37	0.49	0.65	0.36	0.63	0.59	0.77	0.52	0.52	0.59	0.33	0.67	0.51	0.32

The fourth cluster involved KN5, Ural, SW5001, Option501 and NSA-2 which were early ripening genotypes and had higher values of oil percent and harvest index and low values for some traits including stem diameter, number of siliques per plant and height of first silique and first branch from the ground level which are characteristics of spring type oilseed rape. The remaining 21 genotypes included in the 5th cluster had an average values for nearly all assessed traits (Figure1 and table 3).

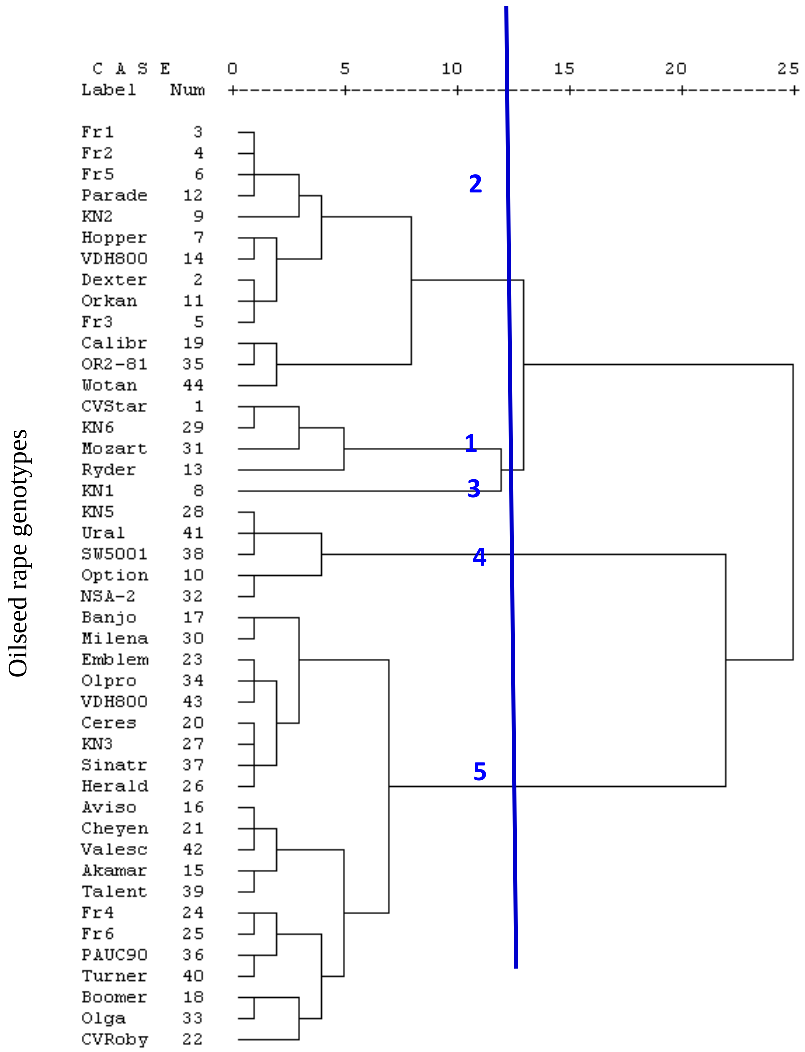

Figure.1. Dendrogram showing the classification of rapeseed genotypes based on squared Euclidean distance and Ward's minimum variance clustering method

According to the distance matrix which has been calculated based on squared Euclidean distance, the genotypes Fr2 and Fr3 had the closest proximity and both of them were belonged to cluster number 2. The greatest distance between genotypes involved the NSA-2 and Ryder which included in the 4th and 1st clusters respectively (Data not shown) (Figure 1).

Table 3. Mean of traits for different clusters obtained from clustering

Cluster number		**1**	**2**	**3**	**4**	**5**	**Total**
Number of members		**4**	**13**	**1**	**5**	**21**	**44**
Traits	Days to flowering	**185**	187.5	**179**	**180.7**	188.2	186.7
	Days to end flowering	**214.1**	223.7	**213**	**210.9**	225.9	222.2
	Flowering duration	29.1	**36.1**	34	30.1	**37.7**	35.5
	Plant height	**89**	**90.2**	**94.7**	67.4	81.2	83.3
	Stem diameter	**7.1**	**7.4**	6.9	5.6	6.8	6.9
	Number of branches	**5.4**	4.9	**7.7**	4.8	4.6	4.9
	Number of siliques/main stem	**34.8**	**30.4**	**33**	22.3	22.7	26.2
	Number of siliques/branches	91.6	**108.8**	**188.4**	68.7	95.2	98
	Number of siliques/plant	126.4	**139.2**	**221.4**	90.9	117.8	124.2
	Main stem length	36.5	**41.3**	35.8	29.3	35.4	36.6
	No. of grains/main siliques	62.6	49.7	15.8	85.9	123.4	89.4
	No. of grains/secondary siliques	58.4	45.5	17.7	90.4	126.8	90
	Main siliques length	6	**6.3**	4.3	5.5	**6.3**	6.1
	Secondary siliques length	5.5	**5.9**	4.3	5.5	**6**	5.8
	First silique height	55.9	55.5	64.3	43.2	52.4	52.9
	First branch height	20.3	18.3	23	14.8	16.9	17.5
	1000 grain weight	**3.9**	**3.7**	2.8	3.6	3.6	3.6
	Oil percent	**45**	42.1	42.7	**44.9**	41.6	42.4
	Biological yield	**9.8**	7.8	7.8	6.4	7.8	7.8
	Grain yield	**2.27**	1.32	1.23	1.31	1.25	1.37
	Harvest Index	**23**	16.8	15.9	**20.4**	15.8	17.3
	Oil yield	**1.02**	0.56	0.52	**0.59**	0.52	0.58

Fisher's canonical discriminant analysis on 5 distinct groups originating from cluster analysis resulted in 2 canonical functions which effectively separated all members of the groups without any coincidences (Figure 2) and thus confirmed the accuracy of dendrogram cutting point (Data not shown).

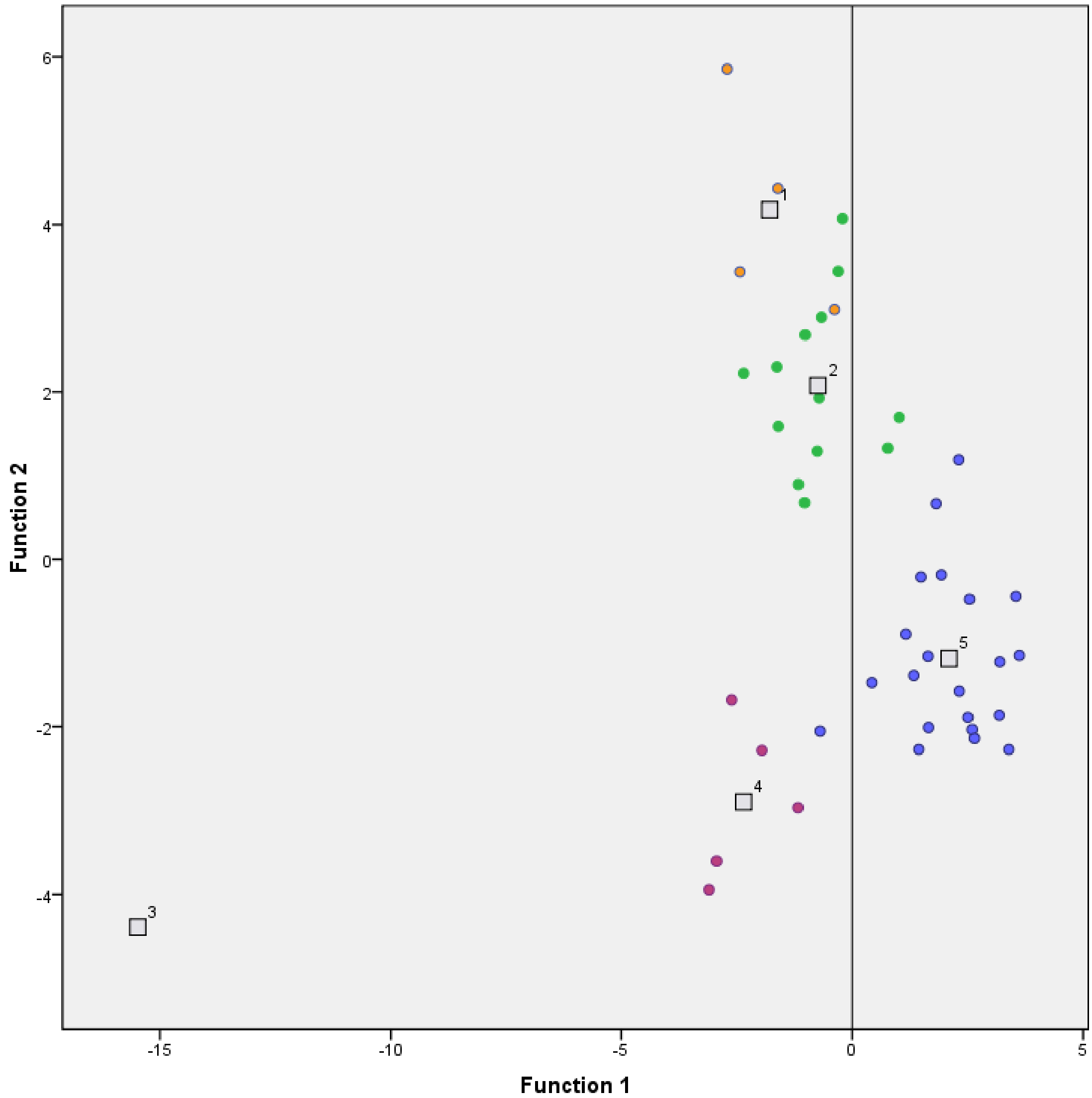

Figure.2. Scatter diagram of oilseed rape genotypes belonging to 5 clusters using two canonical discriminant functions scores.

REFERENCES

[1] Aien A. 2007. Study on yield potential of advanced rapeseed varieties in Jiroft area. Pajouhesh & Sazandegi 77: 119-124 (In Persian with English abstract).

[2] Cruz V M V, Luhman R, Marek L F, Rife C L, Shoemaker R C, Brummer E C, and Gardner C A C. 2007. Characterization of flowering time and SSR marker analysis of spring and winter type *Brassica napus* L. germplasm. Euphytica, 153: 43-57.

[3] Diers B W and Osborn T C. 1994. Genetic diversity of oilseed *Brassica napus* germplasm based on restriction fragment length polymorphisms. Theor. Applied Genet. 88: 662-668.

[4] Hallden C, Nilsson N O, Rading I M, and Soll T. 1994. Evaluation of RFLP and RAPD markers in a comparison of *Brassica napus* breeding lines. Theor. Applied Genet. 88: 123-128.

[5] Fanaei H R, Ghanbari A, Akbarimoghadam H, Galavi M, and Naruoyrad M R. 2010. Assessment of the yield, yield components and some agronomic traits of rapeseed Spring genotypes in Sistan region. Pajouhesh & Sazandegi 79: 36-44 (In Persian with English abstract).

[6] FAO. 2011. FAOSTAT, available on line from URL: http://faostat.fao.org/faostat/form/collection=Production.

[7] Gangapur D R. 2008. Studies on genetic variability in the Indian mustard (*B. juncea* L. Czern and Coss) germplasm and its suitability to northern Karnataka. Master of Science (Agriculture) Thesis. Department Of Genetics And Plant Breeding, College Of Agriculture, Dharwad, University of Agricultural Sciences, Dharwad, India.

[8] Heal G, Walker B, Levin S, Arrowg K, Dasgupta P, Daily G, Ehrlich P, Maler K G, Kautsky N, Lubchenco J, Schneider S, and Starrett D. 2004. Genetic diversity and interdependent crop choices in agriculture. Resource and Energy Economics 26: 175–184.

[9] Jordan D R, Tao Y Z, Godwin I D, Henzell R G, Cooper M, and McIntyre C L. 1998. Loss of genetic diversity associated with selection for resistance to sorghum midge in Australian sorghum. Euphytica, 102: 1-7.

[10] Kresovich S, Williams JGK, McFerson J R, Routman E J, and Schaal B A. 1992. Characterization of genetic identities and relationships of *Brassica oleraceae* L. via a random amplified polymorphic DNA assay. Theor. Applied Genet. 85: 190-196.

[11] Rashidifar J, Dehghani H, Alizadeh B, and Khodadadi M. 2010. Classification of some winter rapeseed cultivars using cluster analysis and discriminant function analysis. 11th Iranian Congress of Agronomy and Plant Breeding Sciences. 24-26 July 2010. Institute of Environmental Sciences, Shahid Beheshti University, Tehran.

[12] Romesburg C. 2004. Cluster Analysis for Researchers. Lulu Press, North Carolina, USA.

[13] Steel R G D, and Torrie J H. 1981. Principles and procedures of statistics. A biometrical approach. McGraw-Hill. London. UK.

[14] Wisal, M., Khan, Iqbal Munir, Farhatullah, M. Arif, Aqib Iqbal, Ijaz Ali, Dawood Ahmad, Mushtaq Ahmad, Afaq Mian, Jehan Bakht, Inamullah and Zahoor A. Sawti, 2011. Assessment of Genetic Diversity of *Brassica junicea* Germplasm Using Randomly Amplified Polymorphic DNA (RAPD) Markers, African Journal of Biotechnology Vol. 10(19), pp. 3654-3658.