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Performance of canola genotypes under water availability and deficit in newly reclaimed soil

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Key words: Canola genotypes, Irrigation intervals, Variability and Genetic parameters

Abstract

This study was conducted to determine the effects of drought stress and the important genetic parameters on some canola genotypes. Thirteen genotypes were tested in a split plot design based on randomized complete block design with three replications in 2012- 2013 and 2013-2014 at the experimental Farm of the Faculty of Agriculture, Fayoum University. The results indicated that the analysis of variance for the studied nine traits showed significant and highly significant differences among irrigation intervals, genotypes and the interaction of irrigation x genotypes (I x G) in both seasons for all the traits except I x G interaction for seed index and oil percentage in the 1st season and seed yield per fed. In the 2nd season which exhibited non-significance differences. The means of irrigation treatments showed significantly reduction by increasing drought stress for all traits. The trait means under normal irrigation had higher values than those of drought conditions. The Mean performance of genotypes 12, 10, 11 and 9 responded in this respect to drought stress more than other genotypes. The phenotypic variance was greater than those of genotypic ones for all studied traits and the same trend for phenotypic and genotypic coefficient of variability. The heritability values were ranged from low to moderate values for most studied traits. Expected genetic advance (GA) values except for number of pods/ plant (high value) were low for all studied traits and Genetic advance as percent of mean seemed to be more important than GA values for further improvement in the tested genotypes.

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Introduction

Canola (*Brassica napus* L.) is considered as one of the most important oil crops overall the world where it ranks the third oil crop for oil production after palm and soybean as well as the fifth field crop regarding economic importance, after rice, wheat, maize and cotton. Canola is potentially important due to its good quality edible oil and potential to grow in salt affected soils. Drought is a major stress factor which limits crop production in most areas in the world. Even temporary drought can cause substantial losses in crop yield (Moselev, 1983). The greatest challenge for the coming decades will be the task of increasing food production with less water, particularly in countries with limited water and land resources. Water productivity in terms of output per unit of food per m^3 of used water needs to be increased in both irrigated and rainfed agriculture substantially, in short, more crop per drop (FAO, 2000). Canola due to having desirable physiological traits inable it to classify as relative resistance to water deficiency and salinity (Alyari and Shekari, 2000).

Under Egyptian conditions agriculture manner characterized by hard crop diversification and high competition among the main crops which occupied almost all the old land within the Nile valley. The opportunity of other less monetary crops such as oil crops becomes very limited. Horizontal expansion within the marginal and desert area adding new reclaimed land consider the available solve to overcome this problem and increase the acreage under oil crops. However, the new lands are frequently undergo from abiotic stresses such as drought which being the challenge to agricultural scientists. So, it is essential to select the suitable crop species and varieties withstand the harsh environmental stresses prevalent in these lands. Canola may be the best choice for many reasons. Among these reasons, it's relatively drought tolerance and need low water requirements where it successfully grown in Egypt during winter season (Kandil, 1994). Usually, water deficiency stress in this plant decrease its yield, number of siliquae per plant and the number of seeds per siliqua (Passban-Eslam *et al.* 2000).

Qifuma *et al.* (2006) reported that less-watering stress resulted in the reduction of yield and yield components such as the number of siliquae per plant and the number of seeds per siliqua. Pod numbers per plant, seed and oil yield of canola charply decreased by water stress (Rahnema and Bakhshandeh, 2006). High seed yield with an increase of irrigation number has been reported by Hati *et al.* (2001) and Maleki*et al.*(2013). Irrigation can increase seed yield of canola from 41.7% to 62.9% as compared to unirrigated treatments Panda, *et al.* (2004).The aim of this study was to determine the effects of drought stress and the important genetic parameters on some qualitative and quantitative traits of canola genotypes.

Materials and methods

The present investigation was carried out under harsh environmental conditions at the experimental Farm (Demo, new reclaimed soils) of the Faculty of Agriculture at Fayoum, Fayoum University, during the two successive seasons of 2012/2013 and 2013/2014. The experimental design was randomized complete block in a split plot arrangement with three replications. Canola's (13 genotypes) were taken as sub-plots and irrigation intervals (three levels of irrigations after 12 day, 24 day and 36 day) were taken as main plots. Each plot consisted of five ridges (4 m long and ridge spacing of 25 cm). Planting was done in hills 10cm apart on two sides of the ridges. Thinning was done four weeks after planting, and two plants were remained in each hill. Phosphorus fertilizer at the rate of 23 kg P_2O_2 /fad and potassium fertilizer at the rate 24kg K_2O /fad were added during the filed preparation. Nitrogen fertilizer at the rate of 60 kg/fad was added in three portions, 15 kg at planting and 20kg each before second and 25kg before third irrigation. At maturity, 10 plants were selected randomly in each plot to measure the plant height, cm (PL.H), height to the first branch, cm (H. 1st Br), number of branches/plant (No. Brs), number of pods/plant (pods), seed yield /plant, g. (SY/PL) and seed index (weight of 1000- seeds), g. (SI), In addition, the following three traits (on plot basis) were measure the seed yield/Fed, t (SY/Fed), seed oil content percentages, (Oil %) and seed protein content (protein %).

The last two traits measured by Near Infrared analyzer (Granlund and Zimmerman, 1975). This experiment was carried out using 13 genotypes of canola originated from completion of earlier study (Khalaf, 2011). The origin and pedigree of these genotypes are shown in table (1).

Table 1. The origin and pedigree of the tested entries.

Genotypes (G)	Name	Pedigree	Origin
1	P_1 (35/9)	C103/SIDO*2C1039C-6SU-1SU-13SW-2SW0SW	Egypt
2	P_2 (26/18)	18C-21SU-4SW-15SW-1SW-0SW	Egypt
3	P_3 (DUPLO)	VARIETY	Germany
4	P_1ẋP_2(BC_{14})	______	Egypt
5	P_1 ẋP_2 (F_4)	_______	Egypt
6	P_1 ẋP_2 (BC_{24})	_______	Egypt
7	P_1ẋ P_3(BC_{14})	_______	Egypt
8	P1 ẋ P3(F_4)	_______	Egypt
9	P_1ẋ P_3(BC_{24})	_______	Egypt
10	P_2ẋ P_3 (BC_{14})	_______	Egypt
11	P_2ẋ P_3(F_4)	_______	Egypt
12	P_2ẋ P_3(BC_{24})	_______	Egypt
13	SERW 4	Local variety	Egypt

Statistical analysis

The obtained data were subjected to analysis of variance and means were computed by LSD test (Gomez and Gomez 1984). The phenotypic (σ^2p) and the genotypic (σ^2_g) variance were calculated according to the following formulae (AL-Jabouri *et al.* 1958). The phenotypic and genotypic coefficients of variation were estimated using the formulae developed by Burton (1952). Heritability in broad sense (H_{bs}) and genetic advance (GA) was calculated with the method suggested by Allard (1960) and Singh and Chaudhary (1985) and GA as % of mean (GAM) = GA/mean value * 100.

Results and discussion

The results obtained in this manuscript and their discussion presented here for each trait as affected by the variables studied, i.e. irrigation intervals and genotypes of canola. The results of the analysis of variance for the studied nine traits showed highly significant differences among irrigation intervals for all the traits in both seasons except height to 1st branches was significant in 1st season and highly significant in 2nd season (Table 3).

Also, highly significant differences among genotypes were observed for all traits in both seasons, except seed yield/plant and fed in 1stseason were significant (Table 3). This indicated the presence of appreciable level of differences among genotypes for mostly all the studied traits and justifies carrying out further genetic analysis. The result also suggested ample scope of selection for different quantitative traits under drought for the improvement the crop.

The interaction of irrigation x genotypes (I x G) revealed highly significant differences for plant height, number of branches/plant, number of pods/plant and seed yield per plant in two seasons, and significant differences of I x G was observed for height to 1st branch in 1st season and seed index and oil percentage in 2nd season (Table 3).However, I x G interaction exhibited non-significance difference for seed index and oil percentage in the 1st season and seed yield per fed. in the 2nd season. Similar to the present results reported by Abbasia and Shirani Rad (2011) and Shirani Rad *et al.* (2013).

Table 2. Mean squares from analysis of variance for the studied 9 traits of 13 canola genotypes under three irrigation intervals at 1st season (2012-2013).

S.V	d.f.	Mean Squares								
		Plant height (cm)	Height to 1st branches (cm)	No. of branches /plant	No. of pods /pant	Seed yield /pant (g)	Seed index (g)	Seed yield /fed. (t)	Oil percentage (%)	Protein percentage (%)
Rep's	2	15.192	21.47	0.31	1087.25	118.329	0.2748	0.0249	0.0049	0.357
Irrigation (I)	2	703.038**	408.29*	7.83**	24911.72**	164.861**	2.6493**	0.2820**	14.5556**	14.8126**
Error (a)	4	14.167	3.68	0.09	841.10	7.909	0.0601	0.0072	0.5544	0.2003
Genotypes (G)	12	90.783**	56.18**	0.59**	9524.37**	61.248*	0.2434**	0.2953*	3.6195**	1.7029**
I x G	24	25.136**	10.24*	0.18**	1246.61**	8.362**	0.0794 ns	0.0031**	0.3116 ns	0.4661**
Error (b)	72	11.074	5.65	0.09	448.74	3.309	0.0788	0.0023	0.3146	0.2197
C.V%		4.51	8.67	6.61	9.92	10.67	7.73	2.64	1.28	1.28

*, ** and ns, significant difference at $P<0.05$, $P<0.01$ and non-significant, respectively.

Table 3. Mean squares from analysis of variance for the studied 9 traits of 13 canola genotypes under three irrigation intervals at 2nd season (2013-2014).

S.V	d.f.	Mean Squares								
		Plant height (cm)	Height to 1st branches (cm)	No. of branches /plant	No. of pods /pant	Seed yield /pant (g)	Seed index (g)	Seed yield /fed. (t)	Oil percentage (%)	Protein percentage (%)
Rep's	2	4.502	3.756	0.365	285.40	145.342	0.128	1.3608	0.158	0.2588
Irrigation (I)	2	1160.095**	704.538**	7.790**	32308.15**	208.659**	5.295**	0.1629**	12.271**	14.2857**
Error (a)	4	28.004	5.959	0.056	87.22	2.516	0.025	0.0023	0.122	0.0810
Genotypes (G)	12	106.975**	50.474**	1.378**	4629.57**	28.876**	0.503**	0.1678**	3.655**	1.5899**
I x G	24	22.718**	19.513 ns	0.444**	961.48**	6.177**	0.168*	0.0048 ns	0.380*	0.7556**
Error (b)	72	10.017	12.616	0.140	258.83	1.600	0.097	0.0139	0.203	0.1288
C.V%		3.76	14.31	10.30	8.94	8.78	9.73	6.69	1.03	1.46

*, ** and ns, significant difference at $P<0.05$, $P<0.01$ and non-significant, respectively.

The individual means comparison of irrigation treatments (I's) showed significantly reduction by increasing drought stress for all traits. The trait means under normal (I_1) irrigation (12days) had higher values than those of drought conditions (I_2 and I_3), indicating that of these traits were greatly influenced by water deficit. For all traits I_3 treatment caused severe reduction compared with I_2 one in both seasons (Table 5).

Table 5. Mean comparison of irrigation intervals on some traits of canola genotypes in2012-2013 and 2013-2014 growing seasons.

Traits	Irrigation Intervals (I)							
	I_1	I_2	I_3	LSDat5%	I_1	I_2	I_3	LSDat5%
	1st season(2012-2013)				2nd season(2013-2014)			
PL.H	78.51	72.55	70.29	2.366	90.45	82.07	80.21	3.327
H. 1st Br	31.04	26.40	24.82	1.207	29.70	21.94	22.82	1.535
No. Br	4.90	4.37	4.01	0.186	4.15	3.38	3.37	0.149
No. pod	241.48	206.42	192.41	18.235	210.70	175.45	153.66	5.872
SY/pl	19.32	16.47	15.33	1.768	16.87	14.06	12.28	0.997
SI	3.92	3.54	3.43	0.154	3.60	3.13	2.88	0.099
SY/Fed	1.92	1.82	1.75	0.053	1.84	1.73	1.72	0.029
Oil%	44.56	43.43	43.58	0.468	44.42	43.32	43.69	0.219
Pro%	25.37	24.19	24.49	0.281	25.30	24.16	24.39	0.179

Overall irrigation treatments, the genotypes 12 and 10 surpassed other genotypes for height to 1st branch, number of branches/plant, seed index, seed yield/feddan and oil percentage in both seasons. Moreover, genotype 11was superior for height to 1st branch, number of branches/plant, seed index, seed yield /feddan and protein percentage in both seasons.

Also, genotype 9 was superior to other genotypes for plant height, number of branches/plant, seed index, seed yield/feddan and oil percentage and genotype 8 was better than others for height to 1st branch, number of branches/plant, seed index, seed yield/feddan and oil percentage in both seasons, respectively (Table 6).

The interaction of irrigation x genotypes was significant for all studied traits revealing that genotypes 12, 10, 11 and 9 in both seasons responded in this respect to drought stress more than other genotypes (Tables 7 and 8). Similar to the present results reported by Ghallab, (2002 and Shirani Rad *et al.* (2015).

Table 6. Mean comparison of canola genotypes on some traits in2012-2013 and 2013-2014 growing seasons.

Genotypes (G)	PL.H	H. 1stBr	No.Br	No.pod	SY/pl	SI	SY/Fed	Oil%	Prot%
	1st season(2012-2013)								
1	73.68	24.86	4.86	168.87	13.42	3.62	1.48	43.94	24.68
2	72.89	24.76	4.46	185.08	14.80	3.80	1.59	43.62	24.34
3	69.56	23.32	4.29	179.76	14.35	3.73	1.65	42.62	23.88
4	75.71	28.94	4.68	209.12	16.69	3.55	1.87	43.21	24.33
5	73.46	29.36	4.13	197.15	15.78	3.34	1.82	43.09	25.17
6	68.97	26.38	4.27	241.46	19.14	3.76	1.89	43.91	24.69
7	72.64	25.25	4.23	239.28	19.19	3.41	1.75	43.60	25.15
8	76.79	29.68	4.37	219.30	17.50	3.42	1.76	44.11	24.91
9	77.10	26.33	4.69	215.07	17.19	3.63	2.01	44.70	24.85
10	77.31	29.33	3.97	223.61	17.85	3.64	2.00	44.37	24.38
11	72.09	31.45	4.69	234.53	18.71	3.71	2.00	43.78	25.51
12	78.83	29.91	4.48	284.83	22.82	3.90	2.10	44.59	24.46
13	70.16	26.93	4.41	176.62	14.11	3.65	1.84	44.62	24.55
LSD	3.127	2.234	0.275	19.907	1.709	0.264	0.045	0.527	0.440
	2nd season(2013-2014)								
1	85.21	26.57	3.73	200.37	16.04	3.48	1.63	43.49	24.77
2	81.20	23.46	3.54	175.46	14.04	3.14	1.74	43.58	24.49
3	86.49	28.32	3.50	143.95	11.56	3.53	1.61	42.71	23.93
4	82.54	24.48	4.23	158.00	12.67	3.25	1.82	43.00	24.19
5	81.09	24.53	4.33	165.20	13.24	3.14	1.71	43.14	25.20
6	79.59	22.01	3.96	222.72	17.81	2.93	1.73	43.91	24.49
7	89.69	23.01	3.36	184.97	14.87	3.16	1.63	43.45	24.99
8	84.21	20.50	3.62	213.58	17.01	2.69	1.72	44.19	24.89
9	83.84	27.70	3.83	189.23	15.12	3.23	1.77	44.53	24.59
10	85.86	27.53	3.20	170.26	13.64	3.47	1.94	44.44	24.38
11	90.58	25.90	3.66	176.08	14.03	3.25	2.04	43.91	25.41
12	79.81	25.50	3.00	156.47	12.59	3.37	1.93	44.42	24.23
13	85.01	23.14	3.26	182.84	14.64	3.02	1.63	44.71	24.45
LSD	2.974	3.338	0.352	15.118	1.189	0.293	0.111	0.423	0.337

Table 7. Mean comparison the interaction of irrigation intervals (I) and genotypes (G) effect on some traits of canola in 2012-2013 and 2013-2014 growing seasons.

Irriga. (I)	Genotypes (G)	PL.H	H. 1stBr	No.Br	No. pod	SY/pl	SI	SY/Fed	Oil%	Prot%
	1	86.07	26.70	5.13	186.06	14.85	3.65	1.61	45.03	25.27
	2	75.07	26.33	4.73	188.75	15.09	4.04	1.64	44.63	25.53
	3	74.35	28.08	4.63	190.98	15.31	3.97	1.73	43.47	24.00
	4	79.00	32.64	5.32	232.35	18.55	3.83	1.99	43.73	24.73
	5	76.10	33.78	4.87	221.09	17.77	3.78	1.92	43.67	26.07
I_1	6	75.20	30.60	4.67	285.53	22.73	3.89	1.96	44.47	25.30
	7	74.53	27.40	5.00	260.42	20.85	3.91	1.84	44.03	26.13
	8	79.60	38.83	4.90	273.23	21.87	3.82	1.88	44.80	25.53
	9	82.23	29.83	5.13	264.57	21.29	3.79	2.08	45.27	25.60
	10	84.00	32.66	4.48	250.05	19.94	3.90	2.08	45.00	24.73
	11	75.67	33.39	5.33	280.93	22.42	3.93	2.10	44.73	26.23

Irriga. (I)	Genotypes (G)	PL.H	H. 1stBr	No.Br	No. pod	SY/pl	SI	SY/Fed	Oil%	Prot%
	12	85.00	33.83	4.80	307.08	24.74	4.42	2.18	45.37	25.67
	13	73.80	29.51	4.72	198.18	15.79	4.05	1.90	45.07	25.07
I_2	1	70.63	23.44	4.75	175.22	13.97	3.65	1.47	43.57	24.17
	2	72.10	24.75	4.43	188.75	15.09	3.80	1.60	42.63	23.03
	3	68.40	21.03	3.98	190.98	15.31	3.84	1.64	41.83	23.67
	4	75.57	28.32	4.92	232.35	18.55	3.53	1.82	43.07	24.17
	5	73.10	27.67	4.08	186.78	14.88	3.03	1.78	42.67	25.00
	6	70.33	26.23	4.15	254.43	20.24	3.81	1.86	43.63	24.10
	7	73.67	24.73	4.20	241.40	19.43	3.09	1.77	43.40	24.43
	8	75.38	26.17	4.22	178.78	14.17	3.31	1.77	44.17	24.67
	9	74.28	25.97	4.84	186.69	14.85	3.67	2.01	44.13	23.97
	10	75.33	28.96	3.76	203.10	16.20	3.46	2.00	44.07	23.80
	11	69.17	31.57	4.73	213.63	17.01	3.75	2.02	42.90	25.17
	12	77.73	27.60	4.45	273.65	21.80	3.59	2.12	44.37	24.00
	13	67.51	26.78	4.27	157.70	12.64	3.46	1.85	44.20	24.30
I_3	1	64.33	24.43	4.70	145.33	11.45	3.57	1.35	43.23	24.60
	2	71.50	23.20	4.23	177.75	14.23	3.57	1.53	43.60	24.47
	3	65.92	20.85	4.27	157.33	12.43	3.39	1.58	42.57	23.97
	4	72.57	25.85	3.81	162.67	12.97	3.29	1.81	42.83	24.10
	5	71.17	26.62	3.43	183.58	14.70	3.20	1.77	42.93	24.43
	6	61.37	22.31	3.98	184.43	14.44	3.59	1.85	43.63	24.67
	7	69.73	23.62	3.50	216.02	17.29	3.23	1.65	43.37	24.90
	8	75.40	24.04	4.00	205.88	16.46	3.12	1.64	43.37	24.53
	9	74.80	23.18	4.11	193.95	15.42	3.43	1.93	44.70	24.97
	10	72.60	26.37	3.67	217.67	17.41	3.57	1.93	44.03	24.60
	11	71.44	29.40	4.00	209.04	16.71	3.45	1.89	43.70	25.13
	12	73.77	28.30	4.20	273.75	21.91	3.69	1.99	44.03	23.70
	13	69.17	24.50	4.23	173.97	13.89	3.45	1.78	44.60	24.27
LSD at 5%		5.417	3.870	0.476	34.479	2.961	0.457	0.079	0.913	0.763

Table 8. Mean comparison the interaction of irrigation intervals (I) and genotypes (G) effect on some traits of canola in 2012-2013 and 2013-2014 growing seasons.

Irrigation intervals (I)	Genotypes (G)	PL.H	H. 1st Br	No. Br	No. pod	SY/pl	SI	SY/Fed	Oil %	Pro %
I_1	1	91.00	34.00	4.23	280.51	22.47	3.66	1.72	44.27	24.03
	2	87.60	31.50	3.93	219.20	17.54	3.45	1.86	44.63	22.73
	3	91.70	32.22	3.80	173.23	13.88	4.12	1.68	43.60	23.90
	4	92.93	27.86	5.77	171.16	13.71	3.94	1.86	43.50	24.17
	5	89.83	29.49	5.17	183.02	14.67	3.42	1.78	43.40	24.67
	6	82.33	24.45	4.38	247.32	19.79	3.28	1.81	44.40	23.93
	7	98.15	26.12	3.88	216.67	17.44	3.46	1.69	43.70	24.40
	8	91.23	25.45	3.83	242.16	19.24	3.47	1.77	44.93	25.00
	9	92.60	36.88	4.27	225.65	18.04	3.74	1.82	44.87	23.93
	10	91.67	30.87	3.57	184.38	14.80	3.66	2.04	44.97	23.87
	11	94.09	30.57	4.28	202.95	16.21	3.40	2.08	45.00	25.17
	12	85.08	32.37	3.17	164.98	13.28	3.78	2.09	45.03	23.83
	13	87.58	24.33	3.67	227.83	18.24	3.47	1.68	45.13	24.43
I_2	1	82.32	22.63	3.33	157.93	12.62	3.45	1.54	43.40	24.77
	2	81.18	15.87	3.72	156.07	12.60	3.12	1.65	42.40	25.00
	3	84.40	25.82	3.33	140.82	11.34	3.52	1.60	41.60	23.90
	4	74.89	23.25	3.72	160.12	12.81	2.90	1.83	42.57	23.93
	5	78.72	23.75	4.20	176.00	14.11	3.27	1.67	42.90	24.70
	6	76.20	18.34	3.58	229.84	18.42	2.74	1.68	43.67	24.47
	7	88.83	22.23	3.17	191.50	15.43	3.09	1.63	43.37	24.63
	8	81.92	16.50	3.64	207.73	16.58	2.76	1.68	43.67	24.37
	9	79.93	23.50	3.40	180.77	14.45	3.13	1.77	44.13	24.43
	10	85.10	26.37	3.00	169.38	13.55	3.61	1.91	44.03	24.53
	11	88.83	23.40	2.87	173.96	13.73	3.12	2.04	43.20	24.77

Irrigation intervals (I)	Genotypes (G)	PL.H	H. 1st Br	No. Br	No. pod	SY/pl	SI	SY/Fed	Oil %	Pro %
	12	78.92	20.10	3.00	155.17	12.54	3.34	1.82	44.00	23.40
	13	85.67	23.43	2.94	181.50	14.57	2.67	1.61	44.17	24.13
I_3	1	82.32	23.09	3.64	162.67	13.04	3.32	1.63	42.80	24.77
	2	74.83	23.00	2.97	151.10	11.97	2.84	1.70	43.70	24.49
	3	83.38	26.92	3.38	117.80	9.45	2.96	1.55	42.93	23.93
	4	79.80	22.33	3.20	142.73	11.48	2.92	1.78	42.93	24.19
	5	74.72	20.35	3.63	136.58	10.94	2.72	1.69	43.13	25.20
	6	80.23	23.23	3.93	191.00	15.21	2.77	1.71	43.67	24.49
	7	82.08	20.69	3.03	146.75	11.74	2.94	1.56	43.27	24.99
	8	79.49	19.54	3.40	190.86	15.21	1.83	1.72	43.97	24.89
	9	79.00	22.73	3.82	161.27	12.88	2.81	1.72	44.60	24.59
	10	80.80	25.35	3.02	157.02	12.56	3.13	1.87	44.33	24.38
	11	88.83	23.72	3.83	151.33	12.15	3.24	2.00	43.53	25.41
	12	75.42	24.02	2.83	149.27	11.94	2.98	1.89	44.23	24.23
	13	81.78	21.67	3.17	139.20	11.12	2.92	1.59	44.83	24.45
LSD at 5%		5.152	5.781	0.609	26.186	2.059	0.507	0.192	0.733	0.584

Genotypic and phenotypic variances were high for number of pods/plant, plant height, seed yield/plant and height to 1st branch. However, were low for number of branches /plant, seed index, seed yield/ feddan and oil percentage in both seasons. From the observed results (Table 15 and 16), the genotypic coefficient of variability ranged from 1.88 and 1.41% (oil percentage) to 14.9 and 12.25% (number of pods /plant) in 1st and 2nd season, respectively. Phenotypic coefficient of variability ranged from 1.88 and 1.83% (oil percentage) to 19.84 and 17.39% (number of pods /plant) in 1st and 2nd season, respectively (Table 9 and 10).

In general, the phenotypic coefficient of variability was greater than those of genotypic ones for all studied traits. These results revealed great environmental factors influenced these traits, but with varied effect among them.

For the above mentioned reasons therefore, broad sense of heritability values were low for number of branches/ plant, seed index and protein percentage in both seasons and plant height in the 1st season and height to 1st branch in 2nd one. While number of pods, seed yield/plant, seed yield/fed and oil percentage had moderate values in both second seasons (Tables 9 and 10).

Table 9. Mean, phenotypic and genotypic variances and coefficient of variations; heritability in broad sense and genetic advance estimates of various traits of canola genotypes in 2012-2013 (1stseason).

Traits	Mean ± SE	σ^2_g	σ^2_p	GCV (%)	PCV (%)	h^2_b (%)	GA	GAM (%)
PL.H	73.78 ± 1.11	8.86	24.62	4.03	6.72	35.98	3.68	4.98
H. 1st Br	27.42 ± 0.79	5.61	12.79	8.64	13.04	43.88	3.23	11.79
No. Br	4.43 ± 0.10	0.06	0.18	5.33	9.47	31.65	0.27	6.17
No. pod	213.44 ± 7.06	1008.40	1723.10	14.88	19.45	58.52	50.04	23.45
SY/pl	17.04 ± 0.61	6.44	11.43	14.89	19.84	56.32	3.92	23.02
SI	3.63 ± 0.09	0.02	0.10	3.73	8.60	18.80	0.12	3.33
SY/Fed	1.83 ± 0.02	0.03	0.056	9.87	12.94	58.13	0.28	15.50
Oil%	43.86 ± 0.19	0.37	0.68	1.38	1.88	53.94	0.92	2.09
Prot.%	24.68 ± 0.16	0.16	0.47	1.64	2.77	35.32	0.50	2.01

σ^2_g=genotypic variance, σ^2_p=phenotypic variance PCV=phenotypic coefficient of variance, GCV=genotypic coefficient of variance, h^2=broad sense heritability, GA=Genetic advance, GAM=genetic advance as percent of mean.

Table 10. Mean, phenotypic and genotypic variances and coefficient of variations; heritability in broad sense and genetic advance estimates of various traits of canola genotypes in 2013-2014 (2nd season).

Traits	Mean ± SE	σ^2_g	σ^2_p	GCV (%)	PCV (%)	h^2_b (%)	GA	GAM (%)
PL.H	84.24 ± 1.05	10.77	25.02	3.90	5.94	43.05	4.44	5.27
H. 1st Br	24.82 ± 1.18	4.21	19.12	8.26	17.62	22.00	1.98	7.98
No. Br	3.63 ± 0.12	0.14	0.38	10.21	16.94	36.30	0.46	12.67
No. pod	179.93 ± 5.36	485.64	978.68	12.25	17.39	49.62	31.98	17.77
SY/pl	14.40 ± 0.42	3.03	6.16	12.09	17.23	49.23	2.52	17.47
SI	3.20 ± 0.10	0.05	0.17	6.63	12.71	27.21	0.23	7.12
SY/Fed	1.76 ± 0.04	0.02	0.045	7.42	12.04	38.00	0.17	9.42
Oil%	43.81 ± 0.15	0.38	0.65	1.41	1.83	59.41	0.98	2.24
Pro%	24.62 ± 0.12	0.16	0.50	1.64	2.87	32.46	0.47	1.92

σ^2_g=genotypic variance, σ^2_p=phenotypic variance PCV=phenotypic coefficient of variance, GCV=genotypic coefficient of variance, h^2=broad sense heritability, GA=Genetic advance, GAM=genetic advance as percent of mean.

Expected genetic advance (GA) values except for number of pods/ plant (high value) were low for number of branches/plant, seed index, seed yield/ plant, seed yield/fed, oil and protein percentage, plant height and height to 1st branch in the two seasons. Genetic advance as percent of mean (GAM %) seemed to more important than GA values for further improvement in the tested genotypes. In the first season, GAM values ranged from 2.01 (for protein percentage) to 23.45 (for number of pods/ plant). While in second season, the value ranged from 1.92 (for protein percentage) to 17.77% (for number of pods/ plant).It was noticed that GAM% of number of pods/ plant and seed yield/ plant were of high values in both seasons, indicating that they act as good criteria for successful selection (Tables 9 and 10). Similar to the present results reported by Sharaan and Ghallab (2002).

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