Zagazig J. Agric. Res., Vol. 46 No. (1) 2019 143-155

Biotechnology Research

http:/www.journals.zu.edu.eg/journalDisplay.aspx?Journalld=1&queryType=Master

GENETIC EVALUATION OF NEW PROMISING MUTANT LINES OF CANOLA (*Brassica napus* L.) UNDER THREE GENERATIONS AND TWO DIFFERENT LOCATIONS

Mona E. Farrag[1*], S.S. Soliman[2], I.M. Amer[1] and Rania M. Heakel[1]

1. Plant Rec. Dept. Nuclear Res. Cent., Inshas, Egypt

2. Genet. Dept., Fac. Agric., Zagazig Univ., Egypt

Received: 30/09/2018 ; Accepted: 19/12/2018

ABSTRACT: The present study aimed to evaluate new promising mutant lines for canola under three generations (M_6, M_7 and M_8) and different locations [Ras-Suder-Sina (saline) and Inshas (harsh and poor fertility land)] for seed yield and its attributes, *i.e.* plant height, No. of pods/plant, seed weight/plant and 100 seed weight, as well as oil and protein content with comparison of the mother varieties. Studying the stability of new mutant lines during three generations (2014, 2015 and 2016) under two locations. The evaluation of mutant lines for seed yield and its attributes of mutant lines showed that lines 11,63.74 and 92 possessed highly significant than the other mutants and their parents for No. of pods/plant and seed weight/plant in both locations. The results confirmed more stability for mutant lines at Inshas location than at Ras-Suder location. The genetic response of genotypes under different locations confirmed the more stability of line 8 than the other mutant lines followed by lines 11, 66, 74 and 75. Oil percent was highly correlated with seed yield and its attributes as well as the improvement of seed yielding lead to improvement of oil percent. Protein content showed a negative correlation with almost yield criteria except for seed weight. The important remark of these results is the plant height as morphological criteria could be used as morphological marker for selection of high yielding new lines of canola. The results concluded that line 8 followed by lines 11, 66, 74 and 75 are excellent new genotypes which could be introduced in breeding programs to obtain new Egyptian canola varieties.

Key words: Canola, gamma rays, mutants, genetic analysis, oil (%), protein (%).

INTRODUCTION

Canola is the third largest source of edible oil after soybean and palm oil **(FAS and USADA, 2012)** providing 13% 0f the world supply. All current varieties of rapeseed and canola were developed from *Brassica napus* (2n = 4x = 38, AA CC) and *Brassica rapa*. (2n = 20, AA). Rapeseed is grown primarily as a source of erucic acid, which is not edible but is valuable in high-performance industrial lubricants. In the early 1970s, Canadian plant breeders used conventional breeding techniques to remove the anti-nutritional erucic acid and bitter glucosinolates from rapeseed. Removing these compounds resulted in an oilseed crop that produced edible oil low in saturated fats and a very palatable, high-protein meal for animal feed. They called the word canola (Canadian oil low acid) to describe a crop that is low in both compounds. Canola seed contains approximately 45% oil or more and produce meals with 35-40% protein. It contains 6% saturated fatty acids and 94% unsaturated fatty acids (high in mono-unsaturated fatty acids) and it has 50% less saturated fats than corn oil **(Weiss, 1983)**. Canola oil is used mainly as cooking oil and in shortening and margarine. To be considered canola, the oil and meal must both meet the following standard: oil < 2% erucic acid, meal < 30 micromoles of glucosinolates per gram. Because canola oil is very high in unsaturated fatty acids, it is considered high- quality food oil

* **Corresponding author: Tel. :** +201000509299
E-mail address: mona_farrag5281@gmail.com

that is healthy in human diets **(Friedt and Lühs, 1998; CODEX, 1999; Snowdon *et al.,* 2007)**.

In January 1985, the US Food and Drug Administration (FDA) granted canola oil GRAS (Generally Recognized as Safe) status for use in human foods. This has led to greatly increased sales and demand in the United States, with only part of the demand being met by US production. Canola oil has achieved worldwide commodity status and is used extensively in Japan, Canada and Europe **(Berglund *et al.,* 2007)**. Canola oil is particularly desirable for frying because it has a neutral flavor and can be heated to higher temperatures than many other oils without smoking or burning. Canola meal is a high-protein (34-38%) animal feed used by the dairy cattle, and poultry industries **(Ehrensing, 2008)**.

Availability of genetic variability is the prerequisite for any breeding programme. The induced mutation has been extensively used for developing new genetic variation in crop plants. Literature revealed that more than 2200 mutant varieties of different crops with improved agronomic traits have been developed and released to the farmers for general cultivation all over the world **(Maluszynski *et al.,* 2000)**. Mutagenesis technique has also been successfully employed in rapeseed and mustard by the plant breeders **(Naz and Islam, 1979; Javed *et al.,* 2000)** to alter the genetic architecture of plant and isolate the possible mutants with desired economic plant characters **(Rehman *et al.,* 1987; Mahla *et al.,* 1990; Robbelen, 1990)**. Induction of nine mutant lines of Canola which possessed high seed yield and oil content were shown at **Farrag *et al.* (2012), Farrag (2013) and Amer *et al.* (2016)**. Therefore, the present study aimed to condect genetic evaluation of new promising mutant lines under different seasons and different locations for seed yield and its attributes, as well as oil content with comparison of the mother varieties.

MATERIALS AND METHODS

Materials

Plant materials

Nine mutant lines which were derived from four varieties *i.e.* Serow4, Serow6, Pactol and Evita of canola (*Brassica napus* L.)" in the study of the M.Sc. Thesis" using gamma rays were used at the present study (**Farrag *et al.,* 2012; Farrag, 2013; Amer *et al.,* 2016)**. The important criteria (Seed weight/plant and oil content) for these mutant lines and its original derived varieties were shown at the Table 1.

Methods

Bulked seeds of the best five plants from each line of nine mutants and their parents were sown in experimental design with three replicates at the two locations (Inshas and Ras-Suder) throw three successive generations (M6, M7 and M8) at seasons 2014, 2015 and 2016.

In 2014/2015 season, mutant lines were sown with four parents at two locations, the split- plot design with three replications was used during the evaluation of three seasons (2014/2015, 2015/2016 and 2016/2017). The data were collected on the following characters: plant height, number of pods/plant, seed weight g/plant and weight of 100 seeds (g).

Oil percent and protein (%) of seeds during the last season (2016/2017) were measured.

The data were collected on the following characters.

Seed yield and its attributes during three seasons

- Plant height (cm).
- No .of pods/plant.
- Seed weight/plant (g).

Yield characteristics during the last generation

- Pod thickness. (cm).
- Pod length. (cm).
- No. of seeds/pod.

Vegetative characteristics after 30 days after sowing during last generation

- Plant height (cm).
- No. of leaves/plant.
- Shoot fresh weight (g).

Table 1. Seed weight/plant (g) and oil content for new nine mutant lines and four varieties of canola

Line	Seed yield g/plant	Oil (%)
Serow4	4.25	42.73
8	7.37	48.58
11	8.52	46.76
Serow6	2.4	42.52
38	4.43	48.20
Bactol	2.22	45.40
63	5.59	48.62
66	6.17	48.33
Evita	2.51	43.85
74	6.73	49.79
75	10.07	47.58
87	5.92	47.15
92	6.54	46.66

- Root fresh weight (g).
- Shoot dry weight (g).
- Root dry weight (g).

Seed quality during the last Generation

- Oil (%) of seeds, according to **Mccabe and Smith (1956)**.
- Protein (%) of seeds. According to **Concon and Soltess (1973)**.

Statistical Analysis

- Combined analysis was done according to **Nissen (1983)**.
- Genetic analysis and heritability as well as correlation coefficient were determined according to **Singh and Chaudhary (1993)**.
- Analysis of variance and mean value were analysis according to **Gomez and Gomez (1983) and Singh and Chaudhary (1985)**.

RESULTS AND DISCUSSION

Stability of Nine Mutant Lines Under Two Different Locations and Three Successive Generations

Mean performance of mutant lines for plant height under different conditions

During three generations, plant height (cm) was recorded at maturity stage (Fig. 1). All mutant lines possessed an increase of plant height compared with their parents under the two different locations. At Inshas location, line 38 possessed more stable for plant height during three successive generations. Lines 63, 74 and 75 had intermediate homogeneity at three successive generations, these four mutant lines consider as a good stability under Inshas location.

At Ras-Suder location, the mean performance of plant height was different from generation to generation except line 8 and line 74

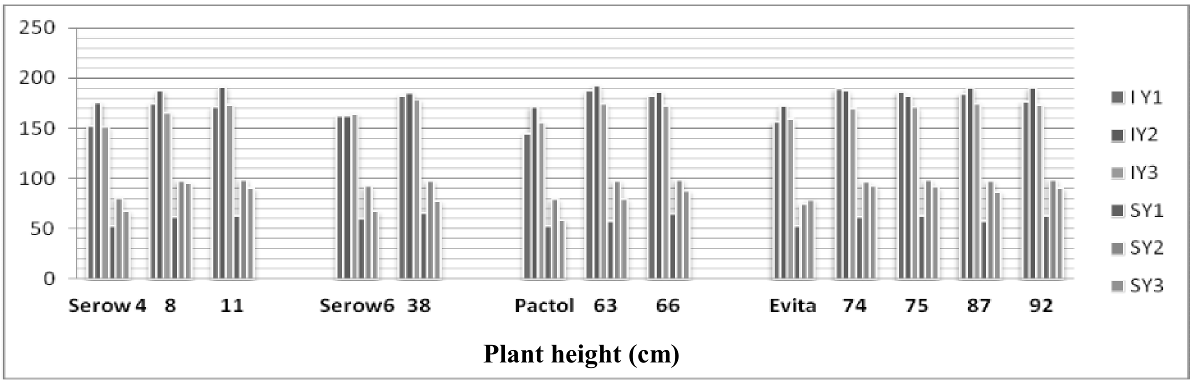

Fig. 1. Average mean of M_6, M_7 and M_8 generations for plant height (cm) of nine mutant lines and their parents at two locations (Inshas and Ras-Suder)

had homogeneity plant height at 7 and 8 generations according to these results, the selection under Ras-Suder location require to more selection generation within these mutant lines except lines 8 and 74.

These results agree with the findings of **Sheikh *et al.* (1999), Rahimi and Bahrani (2011) and Emrani *et al.* (2012)** they found high broad sense heritability for phenological traits, plant height and seed yield demonstrating selection gain for improving these traits will be high. Pods on main axis and pods per plant had high value of genetic coefficient of variation and also were significant correlated with seed yield.

Mean performance of mutant lines for number of pods/plant under different conditions

Large variations were recorded at M_6, M_7 and M_8 generations for number of pods/plant among these lines, except line 38, 66, 74, 75, 87 and 92 possessed more stability for number of pods/ plant at M_6 and M_7 generations, it confirmed the stability of these mutant lines under Inshas location (Fig. 2). At Ras-Suder location, lower number of pods/plant was recorded than Inshas location. The lines 8 and 11 had higher number than other mutants at 7^{th} generation. Therefore these two lines consider as the important lines in the next selection generations.

The results of number of pods agree with studies of **Emrani *et al.* (2012) and Malek *et al.* (2012b)**.

Mean performance of mutant lines for seed weight/plant (g) under different conditions

The same trend for seed weight/plant was observed, long variation was shown between three successive generations (Fig. 3). The mutant line 8 alone more stable for seed weight/ plant for all successive generations at Inshas and Ras-Suder locations. This line consider as an excellent genotype, which it throws to registration new Egyptian variety in canola. Line 8 followed by 63, 66 75, 87 and 92 at Inshas location. At Ras-Suder location line 8 followed only by line 11which they are more stable than other lines. These results agree with these obtained by **Syed and Rahman (2009)**, they mentioned that all the three varieties possess high yield potential, medium-to-high oil content with the local check varieties and respective parents. Growers on appreciable areas are cultivating these varieties.

Genetic Evaluation of Mutant Lines for the Interaction of Two Different Conditions

The interaction between locations and genotypes over the three successive generations

The effect of interaction response between different genotypes and two different locations were recorded at Table 2. At Inshas location, the highly significant of all mutant lines than their parents for all studied criteria were obtained. The large difference for interaction response of mutant lines was detected under different locations. At Inshas location the range between higher and lower mean values between genotypes

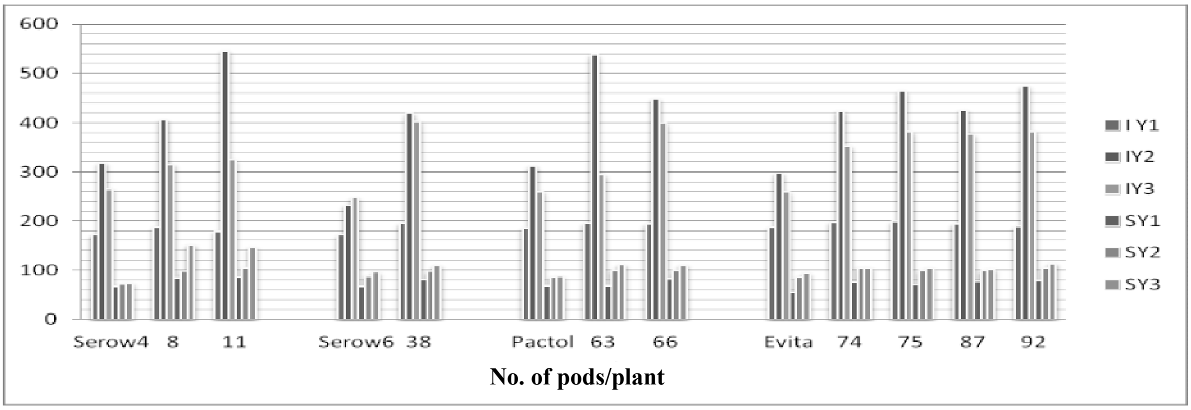

Fig. 2. Average mean of M_6, M_7 and M_8 generations for No. of pods/plant of nine mutant lines and their parents at two locations (Inshas and Ras-Suder)

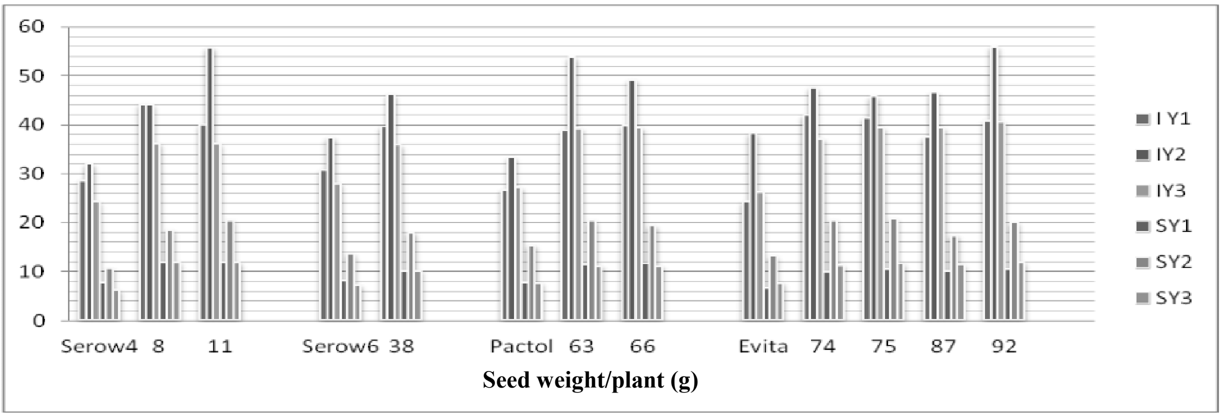

Fig. 3. Average mean of M_6, M_7, and M_8 generations for seed weight/plant (g) of nine mutant lines and their parents at two locations (Inshas and Ras-Suder)

Table 2. Averages of plant height (cm), No. of pods/plant, seed weight/plant (g) and 100 seed weight (g) of 9 lines and their parents in two locations over the three generations

Genotype	Plant height (cm)		No. of pods /plant		Seed weight(g)/plant		100 Seed weight (g)	
	*I	**S	I	S	I	S	I	S
Serow 4	159.8	66.78	264.8	72.22	28.31	8.516	0.3918	0.4299
Line8	174.3	83.67	326.8	111.2	37.15	13.13	0.4384	0.4587
Line11	178.6	83.22	342.9	113.3	41.23	13.63	0.4393	0.4472
Serow6	164.9	69	238.7	83.67	30.36	9.889	0.3876	0.4487
line38	182.9	76.89	352.7	96.11	40.11	12.30	0.4191	0.4461
Pactol	157.6	62.33	261.1	70.22	28.09	8.068	0.4091	0.4256
Line63	185	77.33	376	109.22	39.18	13.19	0.4292	0.4682
Line66	181	81.44	368.1	118.7	38.77	12.49	0.4173	0.4587
Evita	162.8	72.22	264.4	77.78	27.31	8.227	0.4070	0.4254
Line 74	182.8	83.56	335.7	105.33	39.45	13.01	0.4161	0.4438
Line75	179.9	83.78	359	111.33	40.86	12.22	0.4254	0.4491
Line 78	182.7	81.56	344.9	113.67	40.19	11.02	0.4337	0.4414
Line92	179.8	84.89	370.7	128.78	41.3	13.86	0.4210	0.4496
LSD $_{0.05}$	7.463		38.32		4.002		0.02945	

* I = Inshas ** S = Ras-Suder

were (185.0- 157.6) for plant height (376.0-238.7) for No. of pods/plant (41.23-27.31) for seed weight/plant and (0.4393-0.3873) for 100 seed weight. Line 8 possessed highly significant difference than its parent for all studied criteria, followed by line 11, line 66 and line 87 had significant for almost criteria except 100 seed weight. These results confirmed the importance of line 8 for more adaptability than the other lines followed by line 11, line 66 and 87 under both conditions.

These results confirmed that the environmental conditions affect the response of genotypes for saline and harsh land and may polygene mechanisms play a role at genetic control of these environmental conditions. The results agreed with **Puppala *et al.* (1999) and Emrani *et al.* (2012)**.

The interaction between generations and genotypes over the two locations

The mean performance of yield and its attributes in M_6, M_7, and M_8 for mutant lines and their parents showed in Table 3. The mean performance of mutant lines at M_6, M_7 and M_8 showed the importance of the same mutant lines which appeared stability from season to season for No. of pods/plant and seed weight/plant as well as 100 seed weight. Line 8 possessed insignificant value between M_7 and M_8 generations for all studied criteria. These results confirmed the importance of line 8 under different locations and different generations because of more adaptability of this line and subsequently it has broad genotypes which can adaptive under different conditions and different generations. As well as, line 87 had the insignificant values between M_7 and M_8 generations for No. of pods/plant. Moreover, it possessed insignificant values between three successive generations for seed weight/plant and 100 seed weight. So this line considered as important line under different conditions. Therefore, may be ordered of lines which more stability is line 8 followed by line 87.

Lines 66, 74and 75 possessed insignificant values between two generations only for most studied characters and therefore, these lines may be considered for adaptation and testing of them at next generations. These results agree with **Malek *et al.* (2012b) and Amer *et al.* (2016)**.

Evaluation of mutant lines and their parents overall different conditions (Locations and Generations)

Finally, evaluation of mutant lines and their parents overall the three generations (M_6, M_7 and M_8) and the two locations (Anshas and Ras-Suder). With regard to seed weight/plant, the highest value was noticed at mutant line 11. It could be mentioned that comparing the mutant lines with their parent, the all mutant lines significantly arise as showed at Table 4. For plant height and number of pods/ plant criteria, the all mutant lines exhibited significant increases as compared to their parents as illustrated in Table 4. However, only three mutant lines *i.e.,* lines 8, 11 and 63 significantly surpassed 100 seed weight of their parents as shown in Table 4. These findins are in harmony with the results reported by **Malek *et al.* (2012a)**. It was concluded that the overall performance of the two selected mutants, MM-10-04 and MM-08-04, was better than the popular mother variety, BARIsarisha-11. Consequently, the National Seed Board registered MM-10-04, and MM-08-04 in 2011 as two high yielding mustard varieties, Binasarisha-7 and Binasarisha-8, respectively for commercial cultivation in Bangladesh.

Genetic Analysis and Heritability for Vegetative and Yield Attributes at Final Season (M8) Generation as well as, Relationship Between Them of Mutant Lines Under Study

Vegetative criteria after 30 days of sowing during the final season

Highly significant differences among mutant lines and their parents for vegetative criteria, *i.e.,* plant height, No. of leaves/plant, shoot fresh weight, root fresh weight and shoot dry weight at 30 days after sowing (DAS) except root dry weight at 30 DAS (Table 5). These results confirmed the mutants under study possess difference in the genetic background for each mutant, as well as these results good confirmed with agronomic traits especially, seed weight/ plant, No. of seeds/plant and No. of pods/plant. The mild value of heritability for these criteria, subsequently the genetic improvement of these characters could be in the following seasons.

Table 3. Averages of plant height (cm), No. of pods/plant, seed weight/plant (g) and 100 seed weight (g) of 9 lines and their parents at the three generations over the two locations

Genotype	Plant height (cm)			No. of pods/plant			Seed weight(g)/plant			100 Seed weight (g)		
	M_6	M_7	M_8	M_6	M_7	M_8	M_6	M_7	M_8	M_6	M_7	M_8
Serow 4	102.2	128	109.7	136.3	195.3	173.8	18.14	20.83	16.27	0.4043	0.4248	0.4033
Line8	116.3	140.5	130.2	168.8	251.7	236.5	24.28	27.77	23.38	0.4337	0.4570	0.4552
Line11	116.2	145	131.5	165.5	295.2	223.7	22.86	34.57	25.05	0.4355	0.4377	0.4456
Serow6	112.5	128.7	109.7	136.5	161.7	185.3	21.28	21.82	17.27	0.4238	0.4305	0.4000
line38	124.2	141	123.2	160.7	258.2	254.3	24.43	29.16	25.02	0.4227	0.4252	0.4500
Pactol	98.33	126	105.3	133.3	200.3	168.3	17.29	19.65	18.95	0.3968	0.4318	0.4233
Line63	122.3	144.8	126.3	174	319.2	219.7	24.30	29.25	23.50	0.4456	0.4488	0.4517
Line66	123.3	142.3	128	177	275.5	254.8	23.30	27.53	24.56	0.4325	0.4083	0.4383
Evita	104.8	128.5	119.2	132	191.3	190	15.62	21.44	17.30	0.4287	0.4462	0.4117
Line 74	125.3	141.7	132.5	185.3	264.3	228.3	23.33	28.97	23.40	0.4117	0.4185	0.4320
Line75	124.2	140.2	131.2	181.3	281.5	242.7	25.28	29.30	23.54	0.4483	0.4482	0.4450
Line 78	121	143.5	131.8	183.8	262.2	241.8	25.78	27.96	23.07	0.4294	0.4033	0.4433
Line92	119.2	144.9	133.5	196.7	289.3	248.2	23.75	31.99	24.04	0.4227	0.4550	0.4350
LSD $_{0.05}$		9.152			34.17			4.091			0.03607	

Table 4. Characteristics of 9 lines derived from gamma irradiation and their parents over growing at two locations through the three generations

Genotype	Plant height (cm)	No. of pods/plant	Seed weight/plant(g)	100 seed weight(g)
Serow 4	113.3	168.5	18.41	0.4108
Line 8	129	219	25.14	0.4486
Line 11	130.9	228.1	27.43	0.4433
Serow 6	116.9	161.2	20.12	0.4181
line38	129.4	224.4	26.20	0.4326
Pactol	109.9	170.7	18.53	0.4173
Line63	131.2	237.6	25.68	0.4487
Line66	131.8	233.4	25.13	0.4380
Evita	117.5	171.1	18.12	0.4162
Line 74	133.2	215.5	25.23	0.4299
Line75	132.8	225.2	26.04	0.4373
Line 78	132.1	219.3	25.6	0.4376
Line92	132.3	234.7	26.59	0.4353
LSD $_{0.05}$	5.284	34.17	2.83	0. 0283

Table 5. Mean sum of square (MS) and heritability (h^2) for plant height (cm), No. of leaves/ plant, shoot fresh weight, root fresh weight , shoot dry weight and root dry weight after 30 days during the last generation in Inshas location of mutant lines under study

Source	d.f	Plant height (cm) 30 DAS	No. of leaves/plant 30 DAS	Shoot fresh weight 30 DAS	Root fresh weight 30 DAS	Shoot dry weight 30 DAS	Root dry weight 30 DAS
		MS	MS	MS	MS	MS	MS
Replication	**2**	13.407	0.158	5.160	0.063	0.055	0.001
Genotypes	**12**	34.023	0.459	14.177	0.075	0.104	0.004
Error	**24**	6.367	0.112	3.017	0.018	0.046	0.002
h^2 in broad sense		59.146	50.925	55.217	51.351	29.230	23.07

Evaluation of new mutant lines under study for vegetative criteria was shown in Table 6. The comparison between the mean value of each mutant with their parent, showed the very important of line 8 and line 87, which had highly significant value between them and their parents. These results confirmed the importance of these two mutant lines. Line 11 possessed significant difference than the mother variety for plant height, No. of leaves/plant and root fresh weight only. The rest of mutant lines have no significant difference than the mother varieties. The results indicated that findings were in harmony with **Muhammad *et al.* (2007)**, who reported that the increase of No. of irrigation resulted significant increase of seed yield but there is no significant effect on protein and oil content.

Genetic analysis of some yield attributes, oil and protein contents of mutant lines at Inshas location

Genetic analysis of some yield attributes, oil percent and protein content of mutants under study were shown at Table 7, highly significant difference was observed for pod length, pod thickness, No. of seeds/pod, oil (%), and protein content. These large difference confirmed that selection for high yielding will success at next generations. These conclusions confirm with the heritability, especially, oil (%) (86.491%) as well as, No. of seeds/pod (72.781%).

Evaluations of mutant lines for yield attributes, oil (%) and protein content were shown at Table 8. Line 8 possessed highly significant difference than the mother parent for pod length, pod thickness, No. of seeds/pod, and oil percentage. This line had significant value for vegetative criteria (Table 6). This result confirms the very importance of the line 8, which may be directly in the evaluation of new Egyptian variety at Inshas location and the similar conditions. The stability of this line considers as an excellent genotype. Lines 11, 66, 74 and line 75 possessed highly significant for almost criteria. The line 75 had the highest value of oil percent (46.555) than the other genotypes. The lower value of protein content was found for all mutant lines under study, the behavior of protein content were different than the oil percent and other criteria under study.

Finally, the previous results confirmed the importance of line 8, followed by lines 11, 66, 74 and 75. The results indicate that the yield component is an important criteria for yield improvement in canola and this agree with **Seyed *et al.* (2012)**.

Relationship between seed weight/plant and its attributes as well as oil and protein contents for mutant lines under the study of canola

Relationship between seed weight/plant and its attributes, as well as oil percent and protein content were shown at Table 9. Important remarks were discovered in this relationships, firstly positive and significant correlation between plant height and seed weight/plant and its attributes were observed except with 100 seed weight. The second remark was confirmed in the relationship between oil percent and agronomic traits. There was the positive and significant correlation among them except 100 seeds weight. These results confirmed the importance of morphological character as plant height as marker for high yielding in canola, as well as for increase of oil percent. Protein content only possessed negative correlation between almost criteria under study, except 100 seed weight. These results of correlation agree with more previous study, *i.e.,* **(Ali *et al.,* 2002; Seyed *et al.,* 2012)**. They revealed that, highly variation in the treated population than the control for all traits under study specially seed weight/plant was reported. And they mentioned to analyzing the correlation between seed yield and related traits in canola by path analysis and identifying genotypes. And they find the seed weight/plant is useful in breeding high-yielding genotypes in canola under normal or stressed conditions.

Table 6. Evaluation of nine mutant lines and their parents for plant height (cm), No. of leaves/ plant, shoot fresh weight, root fresh weight, shoot dry weight and root dry weight 30 DAS during the last generation at Inshas location

Genotype	Plant height (cm) 30 DAS	No. of leaves/plant 30 DAS	Shoot fresh weight 30 DAS	Root fresh weight 30 DAS	Shoot dry weight 30 DAS	Root dry weight 30 DAS
Serow 4	4.667	20.00	5.773	0.4333	0.560	0.0880
Line8	5.400	25.97	9.333	0.9333	0.9467	0.1500
Line11	5.267	24.93	8.660	0.7867	0.7400	0.1357
Serow6	5.000	22.70	7.423	0.6067	0.7067	0.0946
line38	5.267	24.45	7.720	0.7067	0.7667	0.1167
Pactol	5.000	20.73	6.707	0.4000	0.6400	0.0620
Line63	4.800	23.65	7.113	0.5467	0.7300	0.1037
Line66	4.933	25.90	7.793	0.6133	0.7400	0.1053
Evita	4.800	21.37	7.020	0.5200	0.6367	0.0773
Line 74	5.200	26.00	9.400	0.6967	0.8767	0.1027
Line75	5.200	24.70	7.347	0.7267	0.7733	0.1547
Line 78	5.627	25.83	10.21	0.8733	1.0330	0.1727
Line92	5.267	24.67	7.497	0.6267	0.6700	0.1160
LSD $_{0.05}$	0.5640	4.252	2.927	0.2261	0.3614	0.0532

Table 7. Mean sum of square (MS) and heritability (h^2) for pod length, pod thickness, No. of seeds/ pod, oil (%) and protein (%) during the last generation in Inshas

		Pod length	Pod thickness	No. of seeds/pod	Oil (%)	Protein (%)
Source	**d.f**	MS	MS	MS	MS	MS
Replication	**2**	0.123	0.001	11.179	0.328	3.243
Genotypes	**12**	2.455	0.005	13.641	8.732	22.867
Error	**24**	0.129	0.001	1.513	0.432	2.754
h^2 in the broad sense		85.730	56.521	72.781	86.491	70.881

Table 8. Evaluation of nine mutant lines and their parents for pod length, pod thickness, No. of seeds/pod, oil (%) and protein (%) during the last generation at Inshas location

Genotype	Pod length	Pod thickness	No. of seeds/pod	Oil (%)	Protein (%)
Serow 4	5.533	0.3667	24.33	41.08	20.455
Line8	7.567	0.4833	29.00	44.60	20.415
Line11	8.133	0.4500	29.67	43.76	19.22
Serow6	6.1	0.4000	28.00	41.175	20.854
line38	6.743	0.4833	27.00	44.49	19.979
Pactol	6.733	0.4000	26.00	42.290	20.520
Line63	7.833	0.4500	29.33	45.015	19.687
Line66	8.067	0.5000	29.33	45.280	18.083
Evita	5.633	0.4167	25.00	42.665	21.145
Line 74	7.533	0.4333	27.33	46.555	13.5
Line75	7.133	0.5000	29.00	45.380	14.145
Line 78	5.933	0.4667	27.53	45.130	17.662
Line92	6.667	0.4833	28.33	45.210	17.375
LSD $_{0.05}$	0.6057	0.0532	2.073	2.59	2.183

Table 9. Correlation coefficients (r) between seed yield and its attributes, oil (%) and protein contents for mutant lines and their parents of canola at final season

	Plant height	No. of pods / plant	Seed weight /plant	100 seeds weight	Pod length	Pod thickness	No. of seeds/pod	Oil (%)	Protein (%)
Plant height	1								
No. of pods/plant	0.922029**	1							
Seed weight/plant	0.976366**	0.924429**	1						
100 seeds weight	0.157439	0.072556	0.035028	1					
Pod length	0.62806*	0.691072**	0.722341**	0.052881	1				
Pod Thickness	0.846278**	0.848592**	0.824628**	0.098782	0.553959*	1			
No. of seeds /pod	0.760371**	0.711905**	0.818065**	0.224852	0.805932**	0.718123	1		
Oil (%)	0.860904**	0.802616**	0.874375**	-0.21088	0.589275*	0.717985**	0.529729	1	
Protein (%)	-0.49039	-0.53874*	-0.56061*	0.470338	-0.18902	-0.53029*	-0.34521	-0.55712*	1

* Significant at 0.05 ** Significant at 0.01

These results for correlation confirmed the genetic improvement of seed yield and oil percent is easier in canola for the new mutant lines under study. These results agree with **Mailer *et al.*, (1998).** He found that the high oil content of canola generally work in an inverse relationship to protein level in meal.

REFERENCES

Ali, N., F. Javidfar and A.A. Attary (2002). Genetic variability,correlation and path analysis of yield and its components in winter rapeseed (*Brassica napus* L.). Pak. J. Bot., 34 (2): 145-150.

Amer, I.M., S.S. Soliman, A.A. Hassan and M.E. Farrag (2016). Evaluation of promising mutant lines of canola under new reclamation lands (Harsh lands). 11th Int. Conf. Nucl. Sci. and Appl., 20 – 24.

Berglund, D.R., K. McKay and J. Knodel (2007). Canola production. Cited at www.ag.nsdu.edu.

CODEX (1999). Codex Standard for Named Vegetable Oils. CODEX-STAN 210-1999, Pages1-16.

Concon, J.M. and D.C. Soltess (1973) . Rapid micro-keldahl digestion of cereal grains and other biological materials. Anal. Biochem., 53-55.

Ehrensing, D.T. (2008). Canola oil seed crops, EM 8955-E.oregen state uni. Extension Service.

Emrani, S., A. Arzani, G. Saeidi, M. Abtahi, M. Temeh, M.B. Parsa and M.H. Fotokian (2012). Evaluation of induced genetic variability in agronomic traits by gamma irradiation in canola (*Brassica napus* L.). Bangladesh J. Bot., 41: 111-114.

Farrag, M.E., S.S. Soliman, I.M. Amer and A.A. Hassan (2012). Induction of promising mutant lines of canola under new reclamation lands (harsh and saline). Zagazig J. Agric. Res., 39 (5): 871-880.

Farrag, M.E., S.S. Soliman, I.M. Amer and A.A. Hassan (2013). Application of gamma rays for induction of tolerance mutants to environmental stress conditions in canola. M.Sc. Thesis Agric. Sci. (Genet.) Genet. Dept., Fac. Agric., Zagazig Univ., Egypt.

FAS and USADA (2012). Foreign Agric. Service, United State dept. Agric.

Friedt, W. and W. Lühs (1998). Recent developments and perspectives of industrial rapeseed breeding. Fett-Lipid, 100: 219–226.

Gomez, K.A. and A.A. Gomes (1983). Statistical Procedures for Agriculture Research, 2nd Ed., Philippines Univ. Los Banos, 297-328.

Javed, M.A., A. Khatri, I.A. Khan, M. Ahmad, M.A. Siddiqui and A.G. Arain (2000). Utilization of gamma irradiation for the genetic improvement of oriental mustard *Brassica juncea* (L.) Coss. Pak. J. Bot., 32: 77-83.

Mahla, S.V.S., B.R. Mor and J.S. Yadava (1990). Effect of mutagens on yield and it's component characters in mustard. Haryana Agric. Univ. J. Res., 20: 259-264.

Mailer, R.J., R.T. Cotton and B.L. O'Bree (1998). Quality of Australian Canola. Canola Association of Australia. ISSN 1322-9397.

Malek, M.A., H.A. Begum, M. Begum, M.A. Sattar, M.R. Ismail and M.Y. Rafii (2012a). Development of two high yielding mutant varieties of mustard [*Brassica juncea* (L.) Czern.] through gamma rays irradiation. AJCS, 6 (5): 922-927.

Malek, M.A., M.R. Ismail, F.I. Monshi, M.M.A. Mondal and M.N. Alam (2012b). Selection of promising rapeseed mutants through multi-location trials. Bangladesh J. Bot., 41 (1): 111-114.

Maluszynski, M., K. Nichterlein, L.V. Zanten, and B.S. Ahloowalia (2000). Officially released mutant varieties. The FAO/IAEA. Database. Mut. Breed. Rev., IAEA, Vienna, Austria, 12: 1-84.

Mccabe, W.L. and J.C. Smith (1956). Unit operation of chemical engineering.

Muhammad, T., A.N. Asghar, T. Asif and G.M. Sabir (2007). Performance of canola (*Brassica napus* L.) under different irrigation levels. Pak. J. Bot., 39 (3): 739- 746.

Naz, R.M.A. and R.Z. Islam (1979). Effect of irradiation of *Brassica trilocularis* (yellow sarson). Pak. J. Agric. Res., 17: 87-93.

Nissen, O. (1983). Microcomputer Program for the Design, Management and Analysis of Agronomic Research Experiments.

Puppala, N., J.L. Fowler, L. Poindexter and H.L. Bhardwaj (1999). Evaluation of salinity tolerance of canola germination. in: perspectives on new crops and new uses. ASHS Press, Alex., VA.

Rahimi, M.M. and A. Bahrani (2011) Effect of gamma irradiation on qualitative and quantitative characteristics of canola (*Brassica napus* L.) Middle-East J. Sci. Res., 8: 519-525.

Rehman, A., M.L. Das, M.A.R. Howlidar and M.A. Mansur (1987). Promising mutants in *Brassica campestris*. Mut. Breed. Newsletter, 29: 14-15.

Robbelen, G. (1990). Mutation breeding for quality improvement-a case study for oilseed crops. Mut. Breed. Rev., 6: 1-44.

Seyed, E.E., A. Arzani, G.T. Saeidi, M. Abtahi, M. Banifatemeh, M.B. Parsa and M.H. Fotokian (2012). Evaluation of induced genetic variability in agronomic traits by gamma irradiation in canola (*Brassica napus* L.) Pak. J. Bot., 44 (4): 1281-1288.

Sheikh, F.A., A.G. Rather and S.A. Wani (1999). Genetic variability and inter-relationship in toria (*Brassica campestris* L. var. Toria). Adv. Plant Sci., 12:139-143.

Singh, R.K. and B.D. Chaudhary (1985). Biometrical Methods in Quantitative Genetic Analysis. 2nd Ed. Kalyani Pub. Luuhina, New Delhi, India.

Singh, R.K. and B.D. Chaudhary (1993). Variability, Correlation and Path Analysis Between Kernel Yield and Other Nut Characters in Wild Apricot. Sci. Publishers, Jodhpur, 3: 60-67.

Snowdon, R., W. Lühs and W. Friedt (2007). Oilseed Rape. In: Kole C (Ed) Genome mapping and molecular breeding in plants. Springer, Berlin, 55–61.

Syed, A.S. and K. Rahman (2009). Development of improved varieties of rapeseed and mustard through *in vivo* mutagenesis and hybridization in Pakistan. Q.Y. Shu (Ed.), Induced Plant Mutations in the Genomics Era. Food and Agric. Organization of the United Nations, Rome, 376-378

Weiss, E.A. (1983). Oil seed crops. Longman Group Limited, London, 161-215.

التقييم الوراثي لسلالات طفرية جديدة مبشرة في الكانولا خلال ثلاثة أجيال في موقعين مختلفين

مني السيد فراج[١] - سعيد سعد سليمان [٢] - إبراهيم محمد عامر[١] - رانية محمد يحيي هيكل [٢]

١- قسم البحوث النباتية - مركز البحوث النووية - هيئة الطاقة الذرية - مصر

٢- قسم الوراثة - كلية الزراعة - جامعة الزقازيق - مصر

الهدف من هذه الدراسة هو إجراء تقييم وراثي لسلالات طفرية مبشرة خلال ثلاثة أجيال متتالية (الجيل السادس - الجيل السابع - الجيل الثامن) وموقعين مختلفين ارض ملحية (راس سدر – سيناء) وأرض رملية فقيرة (إنشاص) وذلك عن طريق دراسة محصول البذرة ومكوناته مثل طول النبات، عدد القرون/نبات، وزن بذور النبات ووزن الـ ١٠٠ بذرة بالإضافة إلى محتوى البذور من الزيت والبروتين مقارنة بالآباء، وبدراسة الثبات الوراثي للطفرات الجديدة خلال ثلاثة أجيال متتالية في الأعوام ٢٠١٤، ٢٠١٥ و٢٠١٦ وذلك في كل من إنشاص وراس سدر أظهرت النتائج تفوق السلالة رقم ٨ علي جميع السلالات الأخرى في الثبات الوراثي ويليها السلالات ١١، ٦٦، ٧٤ و٧٥، وبدراسة الصفات المرتبطة بالمحصول أظهرت النتائج أن السلالات ١١، ٦٦، ٧٤ و٩٢ قد تفوقت علي باقي السلالات وكذلك الآباء في صفتي عدد القرون للنبات وزن بذور النبات في كلا الموقعين، وقد أظهرت النتائج ثبات الصفات المدروسة في موقع إنشاص عنه في راس سدر، وبدراسة استجابة التراكيب الوراثية خلال ثلاثة أجيال وموقعين مختلفين أوضحت النتائج تفوق السلالة رقم ٨ مقارنة بباقي السلالات والآباء يليها السلالات ١١، ٦٦، ٧٤ و٧٥، وقد وجد أن صفة نسبة الزيت في البذور مرتبطة ارتباط موجب قوي بصفة محصول البذور ومكوناته مما يعني أن التحسين في الصفات المحصولية يتبعه بالضرورة تحسين في نسبة الزيت في البذور، وقد أظهرت صفة محتوي البذور من البروتين ارتباط سالب مع جميع الصفات تحت الدراسة تقريباً، كما اتضح من النتائج أن صفة طول النبات وهي صفة خضرية يمكن أن تستخدم كدليل مورفولوجي لإنتخاب سلالات جديدة عالية المحصول في الكانولا، وأن الخلاصة من هذا البحث أن السلالة ٨ يليها السلالات ١١، ٦٦، ٧٤ و٧٥ تعتبر تراكيب وراثية متميزة يمكن إدخالها في برامج التقييم لتصبح أصناف كانولا مصرية جديدة.

المحكمـــــون:

١- أ.د. عبدالحميد عبد الحميد علي	أستاذ الوراثة – كلية الزراعة – جامعة كفر الشيخ.
٢- أ.د. عبدالرحمن السيد منــدور	أستاذ الوراثة المتفرغ – كلية الزراعة – جامعة الزقازيق.