J. of Plant Production, Mansoura Univ., Vol. 11 (7):639 - 646, 2020

Journal of Plant Production

Journal homepage: www.jpp.mans.edu.eg
Available online at: www. jpp.journals.ekb.eg

Evaluation of the Efficiency of some Selection Methods in the Segregating Generations for Seed Yield and its Components of Two Flax Crosses

El -Tabakh, M. M. M.*; A. M. A. Okaz; S. S. B. Mourad and M. A. Hager

Department of Agronomy, Faculty of Agricultural, Al-Azhar university, cairo, Egypt.

ABSTRACT

The present investigation was carried out during 2015/2016, 2017/2018 and 2018/2019 successive seasons using the experimental material consisting of flax parents L_{16} , Sakha$_3$, Sakha$_4$ and $L_{541/g/3}$,two flax crosses (L_{16} x Sakha$_3$) , and ,(Sakha$_4$ x $L_{541/g/3}$), and the F_2 ,F_3 and F_4 populations .Genetic variability and divergence studies were conducted among the two crosses of flax.Phenotypic coefficient of variation (PCV) was higher than genotypic coefficient of variation (GCV) for all the observed characters. Based on the present study, high heritability coupled with high genetic advance was observed for seed yield per plant and three of its more important components, number of capsules per plant, number of seeds per capsules and 1000 seed weight .The result suggested the importance of additive gene action for their inheritance and improvement could be brought about by phenotypic selection and may be subjected to mass or progeny or family selection or any selection scheme.The results indicated that the selection indices were more effective than other selection procedures in improving the most characters under study ,while the independent culling levels selection and individual trait selection based on breeding value per plant were surpassed significantly most other selection procedures in improving characters under study among F_2, F_3 and F_4 generations among the two flax crosses .

Keywords: Flax – Selection – Breeding – Value – Independent culling

INTRODUCTION

Flax (*Linum usitatissimum* L.) is an important oilseed crop which is having diploid chromosome number 2n=30. The genus *Linum* comprising over 200 species, belong to the family linaceae..Plant breeders are continuously searching for more effective methods of selection in early breeding generations in order to obtain superior genotypes from a population with a minimum input of labor and time. The major target of flax breeders is to produce high and good quality yielding varieties and for fiber and seed yield.Successful pure-line breeding in self-pollinated plants, like flax by using pedigree selection method requires superior segregation population from which homozygous lines could be selected ,the major disadvantage of this method is the difficulty to identify high yielding lines in early generations (Salas and Fridet ,1995). For this reason, Breeders may delay selection until lines are approaching homozygousity and when sufficient seeds is available to carry out preliminary field test. (Hoffman,1961) defined pedigree and bulk population breeding as the most useful methods for flax. Mourad, (1983) and Abo-Kaied ,(2003) found that independant culling levels selection(ICL). For straw yield and its components gave seed and straw yields which did not differ significantly from selection index or even from some mean of seed and straw yields obtained by individual trait selection based on breeding value per plant for yield and yield components in flax crosses.Therefore independant culling levels selection(ICL) for seed yield and its components was recommended to improve these traits.The present investigation aimed to study the magnitude of variability, heritability estimates and expected genetic advance under selection for seed yield per plant and its components,and comparisons of three methods of selection , selection indices(S.I),individual trait selection based on breeding value per plant(B.V) and independant culling levels selection(ICL) for two flax crosses.

MATERIALS AND METHODS

The present investigation was carried out at the Experimental Farm of El Gemmeiza Agric. Res. Station, during the three successive seasons of 2015/2016, 2017/2018 and 2018/2019.The breeding materials used in present study are F2 generation , F3 lines and F4 progenies of the two flax crosses (L16 x Sakha3) , and (Sakha4 x L541/g/3). These breeding material were planted at the field in three replicates using randomized complete block design in 3 rows 2 m long, spaced 10 cm apart and 5 cm between hills. The two crosses were chosen from a half diallel cross that was made and evaluated for type of gene action for several agronomic trails (El Tabakh , 2017). Data were recorded on four agronomic characteristics, seed yield per plant (S.Y), and three of its more important components, number of capsules per plant,(N.C.P), number of seeds per capsule,(N.S.C), and 1000 seed weight,(1000 S.W).The four variables were used in 16 different selection procedures according to the three methods of selection , selection indices (S.I),individual trait selection based on breeding value per plant (B.V) and independant culling levels selection (ICL).Data were

* **Corresponding author.**
E-mail address: Mohamed.mostafa1982@yahoo.com
DOI: 10.21608/jpp.2020.110563

statistically analysed as the procedure given by (Snedecor and Cochran 1980)

Estimated of phenotypic (PCV) and genotypic (GCV) coefficients of variances were computed followed (Burton,1952).

$$\mathbf{PCV}=(\sqrt{VP}/\bar{x})100. \text{ and } \mathbf{GCV}=(\sqrt{VG}/\bar{x})100$$

Estimated of selection index in F_2, F_3, and F_4 generations:-

The calculation necessary for construction of selection indices can be described under the following headings:-

1- Estimates of phenotypic and genotypic variance and covariance, phenotypic variance for F_2 generation was calculated according to equation $s^2 = \frac{\sum x^2-(\Sigma x^2)/n}{n-1}$ .The F_2 genotypic variance was estimated as the difference between F_2 phenotypic variance and environmental variance. Environmental variance was estimated as the cubic root of the product of variance of the two parents .Phenotypic covariance between any two traits in F_2 generation was computed according to the formula :

$$\mathbf{Cov\ x,y} = \frac{\sum[xy]-\sum(x)\Sigma(y)/n}{n-1}$$

The formula used for estimating heritability in F_2 generation was as follow:-

$$\mathbf{H}= \frac{\sigma^2 F_2 - \sqrt[3]{\sigma^2 F_1 \cdot \sigma^2 p_1 \cdot \sigma^2 p_2}}{\sigma^2 F_2}$$

2- Derivation of optimum weighing coefficients:-

The general index formula mentioned by (Smith, 1936) and (Hazel , 1943). $I = b_1x_1 + b_2x_2 + \ldots + b_nx_n = \sum_{i=1}^{n} b_i x_i$ .The appropriate b ,s which maximize the advance from selection are calculated by the following formula :-

1- for improving two characters while holding the third constant, i.e. restricted selection index, $b= [I_m- p^{-1}GC\ (CG^{-}.\ P^{-1}\ GC)^{-1-}\ CG]\ P^{-1}Ga_i$,(Kempthorne and Nordskog 1959).
2- for improving the four characters, $b = P^{-1}Ga_i$ **,**
3- Calculation of selection indices, phenotypic value of a plant (I) was estimated by using the formula outlined by

$$\mathbf{I}= \sum_{i=1.0}^{n} bi\ xi$$

Independent culling levels selection(ICL): In this method acertain level of merit was stablished for each trait, and all individuals below that level are discarded regardiess of the superiority of their other traits ,(Hazel and Lush ,1942) and (Hallauer *et al* ., 2010)

Calculations in F_3 and F_4 generations : Phenotypic and genotypic variance in F_3 and F_4 generations were calculated by the analysis of randomized complete blocks design as described by(Miller *et al*., 1958),(Table 1)

Table 1. Analysis of variance and expected mean squares of randomized complete blocks design.

S.O.V	D F	M.S	E M S
Replications	r-1	Mr	
Families	t-1	Mt	$\sigma^2 e + r\ \sigma^2 g$
Error	(r-1)(t-1)	Me	$\sigma^2 e$

Phenotypic (σ^2p) and genotypic (σ^2g) variance were estimated by the formula :-

$$\sigma^2 p = \sigma^2 g + \sigma^2 e / r \quad \sigma^2 g = (Mt - Me) / r$$

Calculations of phenotypic and genotypic covariances in F_3 and F_4 generations between pairs of traits,followed the same form as variance analysis,**.**The covariance components for the various sources of variations were as follows:

Table 2. Analysis of covariance between pairs of the studied traits.

S.O.V	Covariance components
Replications	---
Families	σ^2 e . e + r σ^2 a . a
Error	σ^2 e . e

Heritability in F_3 and F_4 generations was estimated as the ratio of genetic variances to the phenotypic variances, according to (Allard , 1960)

$$\mathbf{H}= \frac{\sigma^2 G}{\sigma^2 G+\sigma^2 E}$$

Individual trait selection based on breeding value per plant:B.V.X_1, X_2, X_3 and X_4 seed yield per plant, and three of its more important components, number of capsules per plant, number of seeds per capsule, and 1000-seed weight, respectively The regression of offspring on mid-parent,however,is very little affected and it was taken as avalid measure of heritability as shown by(Reev and Robertson, 1953) .$h^2=bo_{p-}$. The regression of each F_3 offsprings on mid- parent was computed from the equation:-

$$\mathbf{b}_{yx}= \frac{S(xy)-s(x)s(y)/n}{s(x^2)-[(s)]^2/n}$$

The breeding value of each F_2,,F_3 and F_4 plant was obtained by multiplying the regression value of its offsprings on mid- parent by its phenotypic value.

Efficiency of selection procedures:-The expected genetic advance from selecting the best 5% of F_2,F_3,F_4 individuals for the tow flax crosses by using various selection procedures was calculated for the four characters in each crosses by using the formula suggested by (Johanson *et al* ., 1955).

$$\mathbf{GS = K\ \sigma Ph\ .\sigma^2 a\ /\ \sigma^2 ph}$$

Where, K =the selection differential.

σph = phenotypic standard deviation.

σ^2a=the genetic varianc.σ^2ph=the phenotypic variance.

RESULTS AND DISCUSSION

Genetic variability is a pre-requisite for successful selection of superior progenies from segregating generations for further selection and can be created by hybridization. F_2 is an ideal generation in which segregations and recombination are maximum for imposing selection. F_3 and F_4 generations are equally important in the process of selection.The magnitude of recombination potential depends on the genetic diversity of the parents. A population is said to be superior when it shows high mean coupled with high variability.

The mean, standard deviations, PCV and GCV for different characters of the two flax crosses for F_2,F_3 and F_4 generations , have been shown in Table (3). Wide ranges of variability for SY,NCP,NSC and 1000 SW were found in F_2 generation, where as comparable narrow range were detected in the F_3 and F_4 generations among the two flax crosses, The mean of seed yield and its components indicated increase in the mean value from F_2 generation to F_3 and F_4 generations were observed,due to the effect of two cycles of selection in F_3 and F_4 generations as well as the environmental conditions . Estimates of GCV and PCV for all studied characters revealed that the phenotypic coefficient of variation PCV were higher than their corresponding genotypic coefficient of variation GCV, indicating the influence of environment on the expression of these characters . High PCV and GCV were observed for 1000 seed weight in F_2 geneation for cross (L_{16} x $Sakha_3$) followed by number of seed per capsules which were moderate, while number of capsules per plant and seed yield per plant exhibited moderate PCV and GCV ,while PCV and GCV indicated low values for seed yield per plant , number of capsules per plant and 1000 seed weight however number of seed per capsules were moderate among F_3 and F_4 generations. For cross ($Sakha_4$ x L_{541}) High PCV and GCV were observed for SY,NCP,NSC and 1000 SW in F_2 generation,while moderate PCV and GCV were observed for NSC among F_3 and F_4 geneations, while PCV and GCV were indicated low values for SY,NCP and 1000 SW among F_3 and F_4 geneations. For different characters in flax suggesting sufficient amount of variability and thus offering better scope for genetic improvement through selection of these traits.

Table 3. Range ,.mean , heritability(Hb), PCV and GCV,estimates for SY, NCP, NSC and 1000 SW, in F_2,F_3 and F_4 generations, for the crosses (L_{16} x $Sakha_3$) and ($Sakha_4$ x L_{541}).

		L_{16} x $Sakha_3$				$Sakha_4$ x $L_{541/g/3}$			
		SY	**NCP**	**NSC**	**1000SW**	**SY**	**NCP**	**NSC**	**1000SW**
Range	F_2	0.45 - 1.2	13 - 29	33 - 155	4.26 - 21.9	.13 - 1	13 -29	32. - 180	3.8 - 13.6
	F_3	0.72 - 1.17	16.56 - 28	107 - 136	5.68 -10.15	0.55-1.1	15.3 - 23.3	95. -146.3	4.7 - 9.86
	F_4	0.77 - 1.25	18.6 - 27.6	122.- 178	4.72 - 9.57	0.68 - 1.3	15 - 32	105 - 135	5.3 - 11.1
Mean	F_2	0.86± 0.12	18.11± 2.25	100. ± 18.	9.02± 2.92	.87 ± .16	17.3± 2.3	97. ± 22.3	8.85 ±1.6
	F_3	0.92± 0.8	20.52± 1.22	123.8±6.2	7.51± 0.67	.95 ± .08	19.25 ± 1.0	116.2 ± 5.1	8.2 ± .71
	F_4	0.99± 0.6	22.36± 1.13	147± 5.8	6.79± 0.49	.98 ± .07	19.46± .96	121± 5.6	8.1 ± .72
Hb	F_2	90.62	92.75	93.86	98.94	96.60	94.97	98.61	78.30
	F_3	44.35	67.22	58.58	53.10	50.91	79.53	60.64	52.92
	F_4	57.65	65.06	63.11	64.27	59.75	70.04	53.36	56.05
PCV and GCV	F_2	13.83	12.44	18.15	32.39	18.07	13.41	22.82	18.72
		13.17	11.98	17.59	32.22	17.76	13.07	22.66	16.56
	F_3	0.36	7.32	25.61	4.24	0.48	8.43	19.17	4.30
		0.16	4.92	15.00	2.25	0.24	6.70	11.62	2.27
	F_4	0.25	5.43	21.29	3.32	0.47	5.25	18.55	4.87
		0.14	3.53	13.44	2.13	0.28	3.68	9.90	2.73

Seed yield per plant = (S.Y), number of capsules per plant = (N.C.P), number of seeds per capsule = (N.S.C) and 1000- seed weight = (1000- S.W)

The heritability estimate for seed yield per plant was high (92.07%) in F_2 generation, and slightly decreased to (66.98 %) in F_3 generation ,while decreased to (57.65%) in F_4 generation, for cross 1 ,while for cross 2 were (96.60 %) in F_2 generation, and slightly decreased to (50.91 %) in F_3 generation, while increased to (59.75 %) F_4 generation .On the other hand heritability estimate for number of capsules per plant were (92.75 %) in F_2 generation, and slightly decreased to (67.22% and 65.06%) in F_3 and F_4 generation, respectively, for cross 1 ,while for cross 2 were (94.97%) in F_2 generation, and slightly decreased to(79.53%) in F_3 generation, while decreased to (70.04 %) in F_4 generation , Heritability estimate for number of seed per capsules were (93.86 %) in F_2 generation, and slightly decreased to (58.58%) in F_3 generation, while increased to(63.11%) F_4 generation for cross 1 , while for cross 2 were (98.61%) in F_2 generation, and slightly decreased (60.64% and 53.36) in F_3 and F_4 generations, respectively. On the other hand heritability estimate for 1000 seed weight were (98.94%) in F_2 generation, and slightly decreased to (53.10 %) in F_3 generation. while increased (64.27%) in F_4 generations. for cross 1 ,while for cross 2 were (78.30 %) in F_2 generation, and slightly decreased (52.92. %) in F_3 generation, while increased to (56.05%) in F_4 generation Similar result was obtained by Payasi *et al*. (2000) , Bhateria *et al*. (2001) , Naik and Satapathy (2002), Abo-Kaied, (2003) , Awasthi (2003) , Adugna and Labuschangne (2004), Joshi , (2004), Patel , (2008), Nagaraja *et al.* (2009) , Bhushan *et al* . (2017) , Choudary *et al.* (2017) and Dhirhi and Mehta (2019)

The above mentioned suggested that a substantial genetic advance in seed yield per plant , number of capsules per plant, number of seed per capsules and 1000 seed weight could be expected from selection .The most value of heritability was high. This indicates that selection for these traits in the genotypes would be most effective for the expression of these traits in the succeeding generations. Therefore, a good improvement can be made if some of these traits are considered as selection criteria in future breeding program, if a heritability of a character is high, selection for such a character is fairly easy as the selected character will be transmitted to its progeny. This is because there would be a close correspondence between genotype and phenotype due to a relatively smaller contribution of environment to the phenotype. It could be indicated from the above mentioned results that a substantial amount of residual genetic variance in the population till F_4 generation, as estimated by the genetic variance components was observed. The magnitude of the genetic variability which persisted in this material was sufficient to lead for further appreciable improvement in advanced generations.

Efficiency of selection procedures to improve seed yield for the cross (L_{16} x $Sakha_3$ and ($Sakha_4$ x $L_{541/g/3}$)

Efficiency of different selection procedures in improving seed yield and its compopnents, measured in terms of the expected and realized respone to selection, are presented in Table (4) for cross (L_{16} x Sasha $_3$) Results indicated that the actual gains realized by the different selection procedures for improving seed yield in F_3 and F_4 generations , exceeded their respective predicated gains in

F_2 and F_3 generations , except those obtained by selection procedures(S.I no. 9, and ICL_{1234}) with values 9.28 and 12.09 %, respectively in F_3 generation, and selection procedures (B.V X_3) with value 8.74 % in F_4 generation. The highest actual efficiency values for improving seed yield realized in F3 generation were (30.81, 30.81, 30.81,30.81,31.20, 0.81, 31.07, 31.07, 26.01, 30.61, 17.40,13.95,16.50 and 24.85%) obtained by the different selection procedures (S.I no. 1, 2, 3, 4,5, 6, 7, 8, 10, 11, B.V X_1, B.V X_2, B.V X_3 and B.V X_4) , respectively.The highest actual efficiency values for improving seed yield realized in F_4 generation were (33.58, 34.38, 34.38, 32.81, 35.82, 34.38, 36.74,36.66, 7.96, 26.00, 36.23, 21.63, 17.13, 18.32 and 20.21% obtained by the different selection procedures(S.I no. 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, B.V X_1, B.V X_2, B.V X_4 and ICL_{1234}), respectively. The ICL_{1234} selection procedures showed highest actual efficiency values for improving seed yield in F_3 generation than (S.I no 9) in F_3 generation , and than (B.V X_3) in F_4 generation.

Table 4. Efficiency of selection procedures, as percentages of F_2, F_3, F_4 generations, for seed yield in terms of the expected and realized respone to selection for two flax crosses

		Cross 1 (L_{16} x $Sakha_3$)		Cross2 ($Sakha_4$ x $L_{541}/g/_3$)	
NO	SP	F3/F2	F4/F3	F3/F2	F4/F3
1	I.1234	30.81	33.58	25.09	36.25
2	I.123	30.81	34.38	25.09	37.05
3	I.124	30.81	34.38	25.09	37.05
4	I.234	30.81	32.81	25.09	37.05
5	I.134	31.20	35.82	25.09	36.99
6	I.12	30.81	34.38	25.47	37.05
7	I.13	31.07	36.74	25.09	37.71
8	I.14	31.07	36.66	25.47	37.71
9	I.23	9.28	17.96	25.09	12.31
10	I.24	26.01	26.00	23.76	34.28
11	I.34	30.61	36.23	25.09	37.79
12	B.V X_1	17.40	21.63	23.12	31.72
13	B.V X_2	13.95	17.13	21.12	12.16
14	B.V X_3	16.50	8.74	12.93	22.22
15	B.V X_4	24.85	18.32	22.43	25.32
16	ICL_{1234}	12.09	20.21	16.67	19.06
	EGS	13.61	10.24	15.68	14.81

For cross (Sakha $_4$ x L_{541}), results indicated that the actual gains obtained by the different selection procedures for improving seed yield in F_3 generation were highest than their respective predicated gains, for selection procedures(SI,no.1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, B.V X_1, B.V X_2, B.V X_4 and ICL_{1234}) respectively, which exceeded the expected genetic advance with actual efficiency values (25.09, 25.09, 25.09,25.09,25.09, 25.47, 25.09, 25.47, 25.09,23.76, 25.09,23.12, 21.12, 22.43 and 16.67 %), while the actual gains obtained by the other different selection procedures, (B.V X_3) were less than their respective predicated gains with actual efficiency values 12.93 % in F_3 generation, while the actual gains obtained by the different selection procedures in F_4 generation were highest than their respective predicated gains, for selection procedures (SI. no. 1, 2, 3, 4, 5, 6, 7, 8, 10, 11, B.V X_1, B.V X_3, B.V X_4 and ICL_{1234}) , respectively, which exceeded the expected genetic advance with actual efficiency values (36.25, 37.05, 37.05, 37.05, 36.99, 37.05, 37.71, 37.71, 34.28, 37.79, 1.72 ,22.22, 25.32 and 19.06 %, respectively, while the actual gains obtained by the other different selection procedures (SI,no. 9 and B.V X_2) were less than their respective predicated gains with actual efficiency values 12.31, and12.16 % respectively . The ICL_{1234} selection procedures showed highest actual efficiency values for improving seed yield in F_3 generation than the selection procedures (B.V X_3) and than (SI, no.9 and B.V X_2) in F_4 generation . These results are in agreement with El-Kilany, (1976) and Mourad, (1983), they reported that the realized resopnses in yield for most of selection procedures were pronouncedly lower in magnitude than their respective expected ones in F_3 and F_4 generations, and they added that results indicate that those results were expected because genotypic variance used to calculate the expected genetic gains were likely baised by certain x environment interaction variance being included in estimates of genotypic value.This point of view was supported by Byth *et al* (1969)who pointed out that, in soybean, the expected genetic gains were less useful, and they concluded that the actual gains computed across environments were the only accurate criteria for comparing the relative values of selection procedures when substantial genotype x environment interaction exist.Data obtained regarding the realized resopnses in seed yield obtained by different selection procedures in improving seed yield revealed that the actual gains in seed yield obtained by restricted selection index were higher than their respective predicated gains in most cases of selection procedures in F_3 and F_4 generation . The highest value of actual gains indicating the pronouncedly effect of different selection procedures in improving seed yield in base population. It could also be shown that individual trait selection based on breeding value per plant for fiber and straw yield and independent culling level selection, were superior in improving these characters. This result coincide with Eagles and Frey (1974) and Mourad, (1983) , who reported that selection for one trait only, was superior in improving that trait. In the meantime , individual trait selection based on breeding value per plant for the components of seed yield, were also superior in improving seed yields. Several workers suggested the use of yield components in selection for improving seed yield (Momtaz, 1965 , Badwal *et al* , 1971 and Vijayakumar and Vasudeva 1975) . The use of selection indices in most cases, were more efficient improving straw and seed yield than independent culling level selection. This results was in agreement with those obtained by (Hazel and Luch 1942) ,who found that selection index method was more efficient than independent culling level selection but it was usually more expensive. Individual trait selection based on breeding value per plant for seed yields, were superior in improving these characters. This result coincide with , Eagles and Frey (1974) who reported that selection for trait only, was superior for improving that trait.

Comparison of selection procedures for cross (L_{16} x $Sakha_3$):-

Means seed yield per plant (S.Y), and three of its more important components, number of capsule per plant,(N.C.P), number of seeds per capsules,(N.S.C),and 1000-seed weight,(1000-S.W), for the lines selected by the sixteen different selection procedures , of the F_2, F_3 and F_4 generations and the two parents of the cross (L_{16} x $Sakha_3$)

with the expected genetic advance under selection are given in Table (5)

Analysis of variance indicated that there were non-significant differences between all of the selection procedures for the seed yield per plant and number of capsule per plant among F_2 ,$F_3$and F_4 generations .For number of seeds per capsules there were non-significant differences in F_2 , generation ,while there were significant differences in F_3 and F_4 generations. For 1000-seed weight there were significant differences in F_2 generation ,while there were non- significant differences in F_3 and F_4 generations.

Seed yield per plant:-

The expected genetic advance decreased from F_2 to F_3 to F_4 generations with values of 25.86, 13.61 and 10.24 respectively for seed yield per plant, this due to decreased of variance. The means of seed yield per plant obtained for different selection procedures in F_3 generation were lower than their respective predicted ones except the selection procedures obtained by selection procedures (S.I no.1 ,2 ,3 , 5 ,6, 7,8, BV X_1 and BV X_4,), respectively, while all selection procedures exceeded their respective predicted in F_4 generation, this mean that these selection procedures were overpridected (El-Kilany ,1976 and Mourad ,1983). All of selection procedures obtained by the three methods of selection for improving seed yield per plant exceeded the higher and the lower yielding parent (Sakha $_3$) and (L_{16}) in F_2 ,F_3 and F_4 generations, except selection procedures (SI no. 9) in F_3 generation were lower than the lower yielding parent (L_{16})

Number of capsules per plant:-

The expected genetic advance decreased from F_2 to F_3 to F_4 generations with values of 23.80, 14.35 and 11.46, respectively, for number of capsules per plant, this due to decreased of variance. All of selection procedures obtained by the three methods of selection for improving number of capsules per plant exceeded the higher and the lower yielding parent among F_2, F_3 and F_4 generations, except selection procedures (BV X_4) in F_2 generation were lower than the lower yielding parent.

Number of seeds per capsule :-

The expected genetic advance decreased from F_2 to F_3 to F_4 generations with values of 35.15, 9.52 and 6.75, respectively for number of seeds per capsule, this due to decreased of variance ,the means of number of seeds per capsules for selection procedures (SI.no. 2 and 7) respectively, exceeded the higher yielding parent (Sakha $_3$), while the other selection procedures (SI.no. 6, 9, BV X_3, BV X_2, BV X_1, ICL_{1234}, 5, 1, BV X_4, 11, 4, 8 and 3) exceeded the lower yielding parent (L $_{16}$). However, selection procedures (SI.no.10) only were lower than the lower yielding parent (L_{16}) in F_2 generation. Analysis of variance indicated that there were significant differences between all of the selection procedures for improving number of seeds per capsule among F_3 and F_4 generations, the means of number of seeds per capsules for selection procedures (SI no. 1, 2, 3, 6, 5, 4, ICL_{1234}, 7 and 8) respectively, exceeded the higher yielding parent (Sakha $_3$),while the other selection procedures (SI.no.11, 10, 9, BV X_4, BV X_2, BV X_1 and BV X_3) exceeded the lower yielding parent (L $_{16}$) in F_3 generation, while in F_4 generation all of selection procedures obtained by the three methods of selection exceeded the higher and the lower yielding parent.

Table 5. Means of SY, NCP, NSC and 1000 SW obtained by the different selection procedures, of segregating generations for the cross (L_{16} x Sakha$_3$).

SY						NCP					
F2		F3		F4		F2		F3		F4	
7	1.04	1	1.13	7	1.18	9	22.1	9	24.87	9	26.53
2	1.02	2	1.13	8	1.18	10	20.9	10	22.73	10	25.56
6	1.02	3	1.13	11	1.18	2	20.6	13	22.63	4	24.24
8	1.00	4	1.13	5	1.17	6	20.5	1	22.22	1	24.11
11	1.00	5	1.13	1	1.16	3	20.4	2	22.22	2	23.89
4	0.99	6	1.13	2	1.16	4	19.9	3	22.22	3	23.89
3	0.97	7	1.13	3	1.16	1	19.6	4	22.22	6	23.89
1	0.94	8	1.13	6	1.16	11	18.9	6	22.22	13	23.67
14	0.93	11	1.13	4	1.15	7	18.8	15	21.95	16	23.48
9	0.92	10	1.09	10	1.09	13	18.8	12	21.58	5	22.87
10	0.91	15	1.08	16	1.09	8	18.7	7	21.00	15	22.80
5	0.90	16	1.05	12	1.05	14	18.27	8	21.00	11	22.64
12	0.87	12	1.02	9	1.02	12	18.20	11	21.00	8	22.47
13	0.87	14	1.01	15	1.02	16	17.83	14	20.82	14	22.33
16	0.86	13	0.99	13	1.01	5	17.80	5	20.69	7	22.27
15	0.85	P2	0.94	14	0.94	P2	17.72	16	19.48	12	21.22
P2	0.84	9	0.94	P1	0.93	P1	16.54	P2	19.20	P2	21.20
P1	0.83	P1	0.90	P2	0.91	15	16.53	P1	18.50	P1	18.9
GS	25.86	GS	13.61	GS	10.24	GS	23.80	GS	14.35	GS	11.46
NSC						1000 SW					
F2		F3		F4		F2		F3		F4	
2	113.3	1	129.06	14	153.42	8	12.68	11	9.56	15	10.16
7	112.69	2	129.06	12	146.78	3	12.59	7	9.41	13	9.83
P2	111.80	3	129.06	7	141.21	4	12.37	8	9.41	14	9.75
6	110.51	6	127.79	8	140.57	10	12.38	10	9.41	12	9.50
9	110.51	5	124.91	11	137.83	11	12.37	4	9.25	P2	8.86
14	106.48	4	123.05	13	137.83	1	11.82	12	9.19	5	8.66
13	102.42	16	121.99	2	136.72	5	11.60	5	9.14	4	8.62
12	102.35	7	121.22	3	136.72	P2	8.76	P2	8.91	11	8.60
16	102.28	8	121.22	6	136.72	6	8.72	1	8.80	1	8.56
5	98.49	P2	119.80	5	136.36	7	8.71	2	8.80	10	8.56
1	96.15	11	118.86	1	135.55	16	8.59	3	8.80	2	8.54
15	95.78	10	116.24	15	134.44	13	8.43	14	8.79	3	8.54
11	92.96	9	115.22	9	134.24	14	8.37	13	8.74	6	8.54
4	91.9	15	115.02	4	133.83	P1	8.4	20	8.68	8	8.46
8	89.76	13	113.46	16	133.62	12	8.21	15	8.64	7	8.43
3	87.47	12	112.08	10	127.44	9	7.79	P1	8.55	P1	8.35
P1	86.55	14	113.02	P2	115.6	15	7.67	9	8.23	16	8.19
10	83.01	P1	98.50	P1	95.7	2	7.29	6	8.18	9	7.69
GS	35.15	GS	9.52	GS	6.75	GS	54.75	GS	14.25	GS	16.04

1000 seed weight:-

The expected genetic advance decreased from F_2 to F_3 to F_4 generations with values of 54.75, 14.25 and 16.04, respectively, for 1000-SW, this due to decreased of variance, the results indicated that the means of 1000 SW for selection procedures (SI. no. 8, 3, 4, 10, 11, 1 and 5), respectively, exceeded the higher yielding parent (Sakha $_3$),While the other selection procedures (SI. no. 6, 7, 16, BV X_2 and BV X_3) exceeded the lower yielding parent (L_{16}). However the other selection procedures (SI. no. BV X_1, 9, BV X_4 and 2) were less than the lower yielding parent (L_{16})) in F_2 generation, the selection procedures(SI. no. 11, 7, 8, 10, 4, BV X_1 and 5) exceeded the higher and the lower yielding parent , while the selection procedures (SI. no. 1, 2, 3, BV X_3, BV X_2, ICL_{1234} and BV X_4) exceeded the lower yielding parent (L_{16}). However the other selection procedures (SI. no. 9

and 6) were less than the lower yielding parent (L_{16})) in F_3 generation. In F_4 generation, the selection procedures obtained by(SI. no. BV X_4, BV X_2 , BV X_3 and BV X_1) exceeded the higher and the lower yielding parent (Sakha $_3$) and (L_{16}) .While the selection procedures (SI. no. 5, 4, 11, 1, 10, 2, 3, 6, 8 and 7) exceeded the lower yielding parent (L_{16}), however the other selection procedures (SI. no. ICL_{123}, and SI. no. 9) were less than the lower yielding parent

Comparison of selection procedures for cross (Sakha$_4$ x $L_{541/g/3}$) :-

Analysis of variance indicated that there were non-significant differences among all of the selection procedures for the seed yield per plan , number of capsules per plant and number of seeds per capsule among F_2 and F_4 generations, while there were significant differences in F_3 generation, however for 1000-seed weight there were significant differences in F_2 , F_3 and F_4 generations. (Table 6)

Table 6. Means of SY, NCP, NSC and 1000 SW obtained by the different selection procedures, of segregating generations for the cross, (Sakha$_4$ x $L_{541/g/3}$)

			SY						NCP		
F2		F3		F4		F2		F3		F4	
7	0.97	1	1.09	7	1.20	6	20.87	1	23.00	9	23.84
2	0.96	2	1.09	8	1.20	9	20.73	2	23	13	22.22
6	0.96	3	1.09	11	1.20	3	20.33	3	23.00	16	21.45
12	0.96	4	1.09	2	1.19	2	20.13	4	23.00	P1	21.20
9	0.95	5	1.09	3	1.19	10	19.80	5	23.00	10	20.82
13	0.95	6	1.09	4	1.19	4	19.53	7	23.00	12	20.82
14	0.95	7	1.09	5	1.19	1	18.93	9	23.00	1	20.62
16	0.95	8	1.09	6	1.19	13	18.93	11	23.00	2	20.56
8	0.94	9	1.09	1	1.18	7	18.73	6	22.93	3	20.56
11	0.94	11	1.09	10	1.17	12	18.60	8	22.78	4	20.56
P2	0.94	10	1.07	12	1.14	14	18.33	10	22.62	6	20.56
3	0.93	12	1.07	16	1.12	16	18.28	13	22.44	15	19.80
4	0.93	15	1.06	15	1.09	11	17.67	16	21.86	11	19.76
5	0.93	13	1.05	14	1.06	5	17.47	12	20.67	5	19.69
10	0.92	16	1.03	9	0.97	8	17.07	15	20.67	7	19.69
1	0.91	14	0.98	13	0.97	15	15.47	P1	20.2	8	19.69
P1	0.85	P2	0.92	P2	0.93	P2	16.16	14	18.67	14	19.18
15	0.72	P1	0.88	P1	0.86	P1	16.08	P2	17.20	P2	16.56
GS	36.02	GS	15.68	GS	14.81	GS	26.28	GS	18.80	GS	13.00
			NSC						1000 SW		
F2		F3		F4		F2		F3		F4	
2	125.31	1	129.4	5	124.72	8	11.47	P2	9.45	10	10.05
7	126.25	2	129.4	1	124.59	10	10.94	P1	8.88	11	9.90
9	124.01	3	129.4	15	124.16	3	10.42	10	8.75	4	9.84
14	118.94	4	129.4	16	122.72	1	10.29	12	8.72	6	9.84
6	117.72	5	129.4	7	122.50	5	10.29	14	8.71	7	9.81
13	116.50	7	129.42	8	122.50	11	10.14	13	8.53	8	9.81
12	111.96	9	129.42	2	122.36	4	9.86	6	8.50	2	9.77
4	110.58	11	129.42	3	122.36	P2	9.11	16	8.47	3	9.77
11	109.66	8	128.89	12	122.22	6	8.52	8	8.45	5	9.59
16	108.91	6	128.35	13	122.03	P1	8.43	11	8.39	1	9.54
5	107.87	13	127.15	9	121.87	2	8.07	1	8.39	16	8.95
P1	107.75	16	125.59	4	121.52	7	8.07	2	8.39	P1	8.72
1	105.49	10	123.36	6	121.52	9	8.07	3	8.39	P2	8.21
3	96.01	P1	115.00	11	121.38	13	7.42	4	8.39	12	8.16
10	91.10	15	113.53	14	116.53	15	6.89	5	8.39	9	8.02
8	86.17	12	113.02	10	116.3	14	6.70	7	8.39	13	7.99
P2	85.16	14	103.81	P1	113.1	16	6.55	9	8.39	14	7.86
15	82.37	P2	94.40	P2	105.233	12	6.09	15	7.14	15	7.75
GS	46.43	GS	8.80	GS	7.47	GS	47.78	GS	13.7	GS	15.46

Seed yield per plant :-

The expected genetic advance decreased from F_2 to F_3 to F_4 generation with values of 36.02, 15.68 and 14.81, respectively ,for seed yield per plant, this due to decreased of variance, the means of seed yield per plant obtained for different selection procedures in F_3 generation were higher than their respective predicted ones except the selection procedures obtained by selection procedures (B.V X_3), while in F_4 generation .The means of seed yield per plant obtained for different selection procedures were higher than their respective predicted ones except the selection procedures obtained by selection procedures, (SI,no. 9 and B.V X_2) .This mean that these selection procedures were overpridected (El-Kilany, 1976 and Mourad ,1983) . Selection procedures obtained by (SI, no. 7, 2, 6, BV X_1, 9, BV X_2, BV X_3, ICL_{1234}, 8 and 11),respectively, exceeded the higher and the lower yielding parent (L $_{541}$) and (Sakha $_4$) in F_2 generation, while the selection procedures(S I. no. 3, 4, 5, 10 and1),respectively, exceeded the lower yielding parent (Sakha $_4$),however (BV X_4), were lower than the lower yielding parent Sakha $_4$),while in F_3 and F_4 generations the means of seed yield per plant for all selection procedures exceeded the higher and the lower yielding parent .

Number of capsules per plant:-

The expected genetic advance decreased from F_2 to F_3 to F_4 generations with values of 26.28, 18.8 and 13,00, respectively. All of selection procedures obtained by the three methods of selection for improving number of capsules per plant (SI,no . 6, 9, 3, 2, 10, 4, 1, BV X_2, 7, BV X_1, BV X_3, ICL_{1234}, 11, 5, 8 and BV X_4) ,respectively, exceeded the higher yielding parent (Sakha $_4$) and the lower yielding parent (L $_{541}$) in F_2 generation. While in F_3 generation .All of selection procedures obtained by the three methods of selection exceeded the higher and the lower yielding parent except selection procedures (BV X_3) only were lower than the lower yielding parent (L_{541}). However in F_4 generation the means of number of capsules per plant obtained by the three selection procedures (SI,no . 9, BVX_2 and ICL_{1234}) exceeded the higher and the lower yielding parent, while the other selection procedures exceeded the lower yielding parent (L $_{541}$).

Number of seeds per capsule :-

The expected genetic advance decreased from F_2 to F_3 to F_4 generations with values of 46.43,8.80 and 7.47 ,respectively, for number of seeds per capsules, this due to decreased of variance,the means of number of seeds per capsules for selection procedures (SI,no . 2, 7, 9, BV X_3, 6, BV X_2, BV X_1, 4, 11, ICL_{1234} and 5) respectively, exceeded the higher yielding parent (Sakha $_4$),while the other selection procedures (SI.no. 1, 3, 10 and 8) exceeded the lower yielding parent (L $_{541}$). However (BV X_4) were lower than the lower yielding parent (L $_{541}$) in F_2 generation, the means of number of seeds per capsule for selection procedures (1, 2, 3, 4, 5, 7, 9, 11, 8, 6, BVX_2, ICL_{1234} and 10), respectively, exceeded the higher yielding parent (Sakha $_4$).While the other selection procedures (BV X_4, BV X_1 and BV X_3) exceeded the lower yielding parent (L $_{541}$) in F_3 generation. While in F_4 generation all of selection procedures obtained by the three methods of selection for improving number of seeds per capsule exceeded the higher and the lower yielding parent (Sakha $_4$) and (L_{541}).

1000 seed weight:-

The expected genetic advance decreased from F_2 to F_3 to F_4 generations with values of 47.78, 15.45 and 13.7, respectively for 1000- SW, this due to decreased of variance. The results indicated that the means of 1000 SW for selection procedures (SI. no. 8, 10, 3, 1, 5, 11 and 4), respectively, exceeded the higher yielding parent (L_{541}). While the selection procedures (SI. no. 6) only exceeded the lower yielding parent, (Sakha $_4$). However the other selection procedures(SI. no. 2, 7, 9, BV X_2, BV X_4, BV X_3, ICL_{1234} and BV X_1) ,were less than the lower yielding parent (L_{541}) in F_2 generation. Morevoer in F_3 generation all selection procedures were less than the highest and lower yielding parent ,in F_4 generation the selection procedures (SI. no. 10, 11, 4, 6, 7, 8, 2, 3, 5, 1 and ICL_{1234}) respectively, exceeded the higher and lower yielding parent . Wheares the other selection procedures (SI. no. BV X_1, 9, BV X_2, BV X_3 and BV X_4) were less than the higher and the lower yielding parent.

The results indicated that the various selection procedures differd in their ranking sequence for means of all studied characters over the three generation, this may be due to the interaction between the the genotype selected by different procedures and the environment, specially that should be noted that F_2, F_3, F_4 generations were grown at three different years 2015/2016, 2017/2018 and 2018/2019, respectively. The results exhibit in most cases that the selection index ranked the first however Individual trait selection based on breeding value per plant were the ranked the scanned, while the third for improving seed yield per plant were the Independent culling levels selection throw the three generations. The results indicated that the selection indices and the independent culling levels selection and individual trait selection based on breeding value per plant were surpassed significantly most other selection procedures in improving seed yield per plant and its components in F_2, F_3 and F_4 generations. Sometimes, the method of selection indices and Independent culling levels were superior in improving seed yield per plant and its components, this conclusion is in agreement with those obtained by Weiss *et al* (1947) and Kalton ,(1948) .Falconer, (1960) mentoined that only the phenotypic values of Individuals can be measured, but it is the breeding values that determines their influence on the next generation. Finney 1962 concluded that in some circumstances Independent culling levels selection and tandem selection might compare more favourably with index selection method. Eagles and Frey (1974) noted that selection for one trait was superior in improving that trait, but indexes and method of Independent culling levels tended to be superior in improving over all economic value. Vijayakumar and Vasudeva (1975) concoluded that indirect selection for seed yield by capsule number, appeared to be the effective method for improving linseed, although,. Kempthorne and Nordskog (1959), suggested the use of restricted selection index to improve some traits while the mean of chosen trait included in the index was held constant.

REFERENCES

Abo-Kaied, H.M.H. (2003). Phenotypic, genotypic variances, heritability and expected genetic advance of yield and its components in F_3 and F_4 generations of some flax hybrids. J Agri. Sci. Mansoura Univ., 28(9): 6553 – 6566

Adugna , W . and M.T. Labuschangne, (2004). Diversity analysis in Ethiopian and some exotic collections of linseed. *South America J. Plant and Soil*, 21(1) : 53-58.

Allard, R.W. (1960). Principles of Plant Breeding. John Willey and Sons. Inc. New York, : 485.

Awasthi, S.K. (2003). Selection indices, correlation and path analysis in F2 and F3 population of linseed (*Linum usitatissimum* L.). M.Sc. (Ag.) Thesis, IGKV, Raipur.

Badwal, S.S; Gill, K. S; and Singh, H. (1971) .Correlation and regression studies in linseed (*Linum usitatissimum* L.) . Indian J. Agric. Sci., 41(5) 475-478.

Bhateria , S; Anju, P; Sharma, J.K; Badiyala, D; and Bhandari, J.C. (2001) . Combining ability for seed yield and its components in linseed (*Linum usitatissimum* L.). J. Oi/seeds Res., 18(1): 44-47.

Burton,G.W.(1952).Quantitative inheritance in grasses. Proc. 6thInt. Grassland Cong.,1:227-283.

Bhushan , S; Sohan, R; Nutan ,V; and Tajwar ,I. (2017). Genetic variability studies in F_2 and F_3 segregating generations for yield and its components in linseed (*Linum usitatissimum* L.) Journal of Pharmacognosy and Phytochemistry 6 (6): 752-755.

Byth , D.E; Caldwell ,B.E; and Weber .C.R. (1969) .Specific and non – specific index selection in soybeans (*Glycine max* L.) Crop Sci. 5:223-226.

Choudhary, A. K; Marker, S; and Rizvi, A .F.(2017). Genetic variability and character association for seed yield in linseed (*Linum usitatissimum* L.) under rainfed conditions. Journal of Pharmacognosy and Phytochemistry.; 6(5):457-460.

Dhirhi,N. and Mehta, N. (2019). Estimation of Genetic variability and Correlation in F_2 segregating generation in linseed (*Linum usitatissimum* L.) - 492 012 (Chhattisgarh), India. *Plant Archives* Vol. 19 No. 1, pp. 475-484

Eagles, H.A. and Frey, K.J. (1974). Expected and actual gains in economic value of oat lines from five selection methods . Crop Sci. 14:861-865.

El-kilany, M.A.(1976).Comparative studies of selection techniques in developing and maintaining Egyptian cotton .Ph.D. Fac. of Agric .Cairo Univ.

EL-Tabakh,M.M.M. (2017). Studies on flax breeding.M.Sc Thesis. Fac. Of Agric.Azhar Univ.

Falconer,D.S. (1960). Introduction to quantitative genetics.Oliver and Boyd,Edinburgh.

Finney,D.B. (1962). Genetic gains under three methods of selection. Genetic.Res.Camb.3:317-423.

Hallauer, A. R; Carena; M. J. and Filho, M. (2010). Quantitative Genetics in Maize Breeding- Springer New York Dordrecht Heidelberg London- Library of Congress Control Number: 2010930230- ISBN 978-1-4419-0765-3

Hazel, L.N. and Luch, J. L. (1942). The efficiency of three methods of selection . J. Hered . 33:393-399.

Hazel, L.N (1943). The genetic basis for constructing selection indexes. Genetics 28 : 476-490.

Hoffman,W.(1961).Lein,*Linum usitatissimum*, L. In:Romer &W.Rudorf(Eds)Handbuch der planzenzuchtung, V 2nd Ed., 264-366.

Johanson, H.W; Robinson, H.F; and Cosmtock, R. E. (1955b). Genotypic and phenotypic correlation in soybean and their implication in selection. Agron. J. 47:477-483.

Joshi, P.K. (2004). Breeding behaviour and association analysis for yield and yield component in linseed (*Linum usitatissimum* L.) Ph.D. Thesis, IGKV, Raipur, C. G.

Kalton, R.R. (1948). Breeding behavior at successive generation following hybridization in soybeans. Iowa Agric.Sta. Res.Bull.358.

Kempthorne, O; and Nordskog , A.W. (1959). Restricted selection indexes. Biometrics 15:10-19.

Miller, P. A; Williams, J. C; Robinson, H. F; and Comstock, R. E. (1958). Estimates of genotypic and environmental variances and covariances in upland cotton and their implications in selection. Agronomy .J. 50(3), 126-131.

Momtaz,A.(1965).Analytical and inheritance studies on economic characters of flax. M.Sc. Thesis, Fac. of Agric .Cairo Univ.

Mourad,N. Kh.(1983) Effect of different selection methods on improving yield in some flax crosses. Ph.D. Thesis, Fac. of Agric .Azhar Univ.

Nagaraja, T. E ; Ajit, K. R; and Golasangi, B. S. (2009). Genetic variability, correlation and path analysis in linseed. *J. Maharashtra Agric. Univ.* 34**.** 282-285.

Naik , B.S. and Satapathy, P.C. (2002). Selection strategy for improvement of seed yield in late sown linseed. Res. on Crops, 3 (3): 599-605.

Patel, N. (2008) . Studies on stability analysis for yield and yield components in linseed *(Linum usitatissimum* L.). Ph.D. (Ag.) Thesis, IGKV, Raipur.

Payasi, S.K; Bose, U.S; and Singh, A.K. (2000). Pooled analysis of genetic parameters in linseed (*Linum usitatissimum* L.). Adv. Pl. Sci., 13(2): 559-562.

Reev, E.C.R. and Robertson, F.W. (1953). Studies on quantitative inheritance .II.Analysis of astrain of Drosophila melanogaster selected for long wings. J. Genet. 51;276-316.

Salas, G. and Fridet, W. (1995). Comparison of bedigrre selection and single seed descent for oil yield in linseed(*Linum usitatissimum* L). Euphytica,83:25-32.

Sendecor, G.W. and Cochran, W.G. (1980). Statistical methods.The lowa state University press. Ames. Iowa.

Smith , F.H. (1936). Adiscriminant function for plant selection. Annals of Eugenics. London,7: 240-250.

Vijayakumar ,S. and Vasudeva , R. M. J.(1975). Studies on quantitative variability in linseed, Analysis of yield components. SABRAO Jouranal 6 (2) :227-228.

Weiss,M.G; Weber,C.R; and Kalton, R.R. (1947). Early generation testing in soybeans. Jour. Amer. Soc. Agron. 39:791-811.

تقييم كفاءة بعض طرق الإ نتخاب في الأجيال الإنعزاليه لمحصول البذور ومكوناته في هجن الكتان

محمد مصطفي محمد الطباخ*، عبد الحميد محمد محمد علي عكاز، سمير سيد بيومي مراد و محمد أحمد السيد هاجر

قسم المحاصيل-كلية الزراعه-جامعة الأزهر القاهره 2020

أجريت هذه التجربة بمحطة البحوث الزراعية بالجميزه في ثلاثة مواسم زراعية وهي2015 /16 ،18/2017و19/2018 لدراسة كفاءة أساليب مختلفة من الإنتخاب علي تحسين محصول الألياف من خلال الإنتخاب لمحصول البذور وثلاثه من أهم مكوناته وهي عدد الكبسولات علي النبات وعدد البذور في الكبسوله ووزن الألف بذره في الأجيال الثاني والثالث والرابع ولأثنين من هجن الكتان وهما , ($Sakha_3 \times L_{16}$) ($L_{541} \times Sakha_4$)وتم اختيار بذور عدد من النباتات المتميزه في صفاتها من التراكيب الوراثيه التي أظهرت معنويه للفعل الإضافي للجين في الجيل الإنعزالي الأول F_2 وزراعة هذة البذور في عائلات للحصول علي الجيل الثالث F_3 و الإنتخاب داخل هذه العائلات وبينها لأختيار النباتات المتميزه في محصول البذور وفي الموسم التالي تم زراعة بذور النباتات المنتخبة من عائلات الجيل الثالث F_3 و ذلك للحصول علي الجيل الرابع F_4 والإنتخاب داخل هذة العائلات وبينها لأختيار النباتات المتميزه في صفاتها . وتم استخدام ثلاث طرق من الإنتخاب وهي دلائل الإنتخاب، الإنتخاب الفردى للصفة على أساس القيمة التربوية للنبات، الإنتخاب المظهرى المستقل للصفه على مستويات. وتتلخص أهم النتائج فيما يلي: أظهرت متوسطات الجيل الرابع قيما أعلي من متوسطات الجيل الثالث والذي أظهر بدوره قيما أعلي من متوسطات الجيل الثاني للصفات المدروسه والتي أوضحت درجة توريث عاليه مع انخفاض الفرق بين معاملي التباين الظاهري والوراثي في كلا الهجينين حيث تشير تلك النتائج إلي امكانية إستخدام هذه الصفات كعوامل انتخاب في تحسين صفة البذور/نبات . أوضحت النتائج أن التحسين الفعلي كان أعلي من التحسين المتوقع في معظم أساليب الإنتخاب المستخدمة في كلا الهجينين . أظهرت مقارنة كفاءة أساليب الإنتخاب المختلفة أن دلائل الإنتخاب كانت أكثر أساليب الإنتخاب كفاءه يليها الإنتخاب المظهرى المستقل للصفه على مستويات ثم الإنتخاب الفردى للصفة على اساس القيمة التربوية للنبات في معظم الحالات في كلا الهجينين. من النتائج السابقه يمكن التوصيه باستخدام الإنتخاب المظهرى المستقل للصفة على مستويات لتحسين محصول البذور ومكوناته في الكتان وذلك لسهولة تطبيقه وعدم احتياجه الي مساحة كبيرة من الأرض لعمل اختبارات النسل للنباتات المنتخبه كما في الإنتخاب الفردى للصفة على أساس القيمة التربوية للنبات وكذلك عدم احتياجه الي حسابات كثيره ومعقدة كما في الإنتخاب بواسطة دلائل الإنتخاب .