Egypt. J. Plant Breed. 13: 155 - 172 (2009)

EVALUATION OF SOME QUANTITATIVE AND QUALITATIVE CHARACTERISTICS IN NINE FLAX GENOTYPES

S.H.A.Mostafa [1], Aziza M.Hassanein[2] and Neamat A. Naguib[2]

[1] Fiber Crops Res. Dept., FCRI, ARC, Giza

[2] Seed Technology Res. Dept., FCRI, ARC, Giza

ABSTRACT

A field experiment was conducted at Giza Agric. Res. Station during the two successive seasons of 2007/2008 and 2008/2009 to evaluate nine flax genotypes namely; Giza 8, Giza 9, Giza 10, strain 402/10/6, strain 435/11/10/3, strain 12, strain 421/3/6/4, strain 4265/1/3 and strain 1563" concerning straw, seed yields, and their attributes and technological characters. Besides, some biotechnological characters were estimated the highest germination percentage (93.2%) for the namely recessed cv. Giza 10 (93.2 %), while it was the lowest in strain 402/10/6 (88.8). Accelerated ageing germination ranged from 64.7 % in strain 2465/1/3 to 75.0 % in Giza 10. The electrical conductivity was much higher in strain 402/10/6 (40.9 $\mu S\ cm^{-1}g^{-1}$) than in strain 2465/1/3 (23.2 $\mu S\ cm^{-1}g^{-1}$). On the other hand, seedling characteristics such as radical length, shoot length, seedling dry weight and seedling vigor index slightly varied among genotypes. Variation in the chemical components was related to genetic constitution of genotypes. Crude protein ranged from 21.5% in strain 2365/1/3 to 24.2 % in Giza 10. Total carbohydrates ranged from 22.8% in Giza 8 to 24.7 % in Giza 10. Oil percentage ranged from 34.8 % in Giza 10 to 41.0 % in strain 2465/1/3. There was clear variability in morphological characters between all flax genotypes. Giza 9 variety ranked first in relation to total length, technical length, straw yield/fad., fiber yield/fad., fiber length and fiber fineness, while strain 435/11/10/3 surpassed the other genotypes in straw weight/plant. In the same time, strain 421/3/6/4 recorded the highest value for stem diameter. strain 2465/1/3 gave the maximum estimates for number of capsules/plant, seed weight/plant, seed index, seed yield/fad and oil yield/fad. strain 1563 was the tallest one in upper branching zone length. Giza 10 variety out yielded the other genotypes regarding fiber percentage. DNA(RAPD) analysis made resolution for the development of unique fingerprint for each of these genotypes. The dendrogram divided these genotypes into two main clusters where Giza 9 was in a separate sub cluster and all the other strains were in the second sub cluster. The highest similarity observed between strain 12 and strain 2465/1/3, while, the lowest similarity was observed between Giza 8 and Giza 9.

Key Words: ***Flax, Linum usitatissimum L., Straw, Fibers, Seed vigor, Chemical characteristics, DNA (RAPD), Fingerprint***

INTRODUCTION

Flax (*Linum usitatissimum* L.) is an ancient crop, Egyptians knew flax since thousands of years and grewn this crop as a dual purpose for its fibers, extracted from the stems by retting process, and oil obtained from seeds. The long fibers spun into linen yarns, moved into toweling, clothing fabrics, table linen and textiles. The short fibers (tow), are used for twins, paper manufacture and packing. The oil obtained from seeds is considered an important source of essential polyunsaturated fatty acids (PUFA) in the human diet, therefore, it is used as edible oil for human consumption and in some medical industries. Also, linseed oil is used in paints, varnishes and inks. Linseed meal is used as fodder for livestock. The total cultivated flax area in Egypt was about 12833 fadans in 2006/2007 and the total production from its fiber and oil is not enough to cover domestic needs. It is necessary to increase flax productivity from the present limited area; which could be achieved by growing higher yielding cultivars or by improveming agricultural practices. There are great efforts made by Fiber Crops Research Department, ARC. for the advancement of this crop by developing high-productivity and high-quality cultivars. Flax genotypes have been evaluated regarding yield, yield components, quality of fibers and seeds in addition to oil chemical compassion. Many investigators indicated significant differences among flax genotypes such as Momtaz *et al* (1989), El-Farouk *et al* (2003), El-Shimy and Ashry (2003), Mourad *et al* (2003), El-Kady and Kineber (2004), El-Emary *et al* (2006), El-Sweify *et al* (2006), Mostafa *et al* (2006), Atta *et al* (2007) and Zahana and Abo-Kaied (2007).

The importance of seed quality in realizing full potential of a cultivar is well known. Seed quality includes seed viability and seedling vigor (ISTA 1987). High standard germination does not always result in rapid and uniform emergence or vigorous stand under actual planting conditions. On the other hand, seed vigor denotes to the ability of a seed to germinate rapidly and produce a normal seedling under a wide range of conditions (Dornbos 1995). Perry (1989) suggested that a vigor test would provide a better indication of seed performance in the field than the standard germination test.. There is no one universal vigor test for all seeds. A wide array of testing methods has been used to characterize seed vigor. According to Ellis (1992), Saeidi (2008), seed vigor can be assessed in laboratory and various procedures can be used to detect high and low vigor seed. Several examples of seed vigor tests include the accelerated ageing test and electrical conductivity test. The electrical conductivity test is more commonly used for determining seed vigor of crops.

Several authors studied the chemical constants of flaxseed. For instance, the crude protein was 27- 29. % for different genotypes as estimated by Abd El- Rhaman (2005). Total carbohydrates were 23.1% as measured by El-Ghobashy *et al* (2002). Moisture percentage was 5 % as

estimated by Malcolmson *et al* (2000). Ash ranged from 3.0 to 4.9 percentage as was found by Abd El- Rhaman (2005). Crude fiber percentage was 3.8-5.2% as determined by the same author. Oil percentage was 43.4% and 35.2% as mentioned by Malcolmson *et al* (2000) and El-Ghobashy *et al* (2002), respectively.

Molecular markers generated by different techniques developed in the 1980s and 1990s have become powerful tools to examine genetic variation because of a large number of polymorphic markers that become available. Due to its simplicity and speed, RAPD analysis is one of the most-commonly used techniques because it produces numerous molecular markers. DNA marker systems are useful tools for assessing genetic diversity levels among germplasm (Lee 1995 and Karp *et al* 1996) compared with pedigree information, DNA marker-based diversity estimates better reflect actual DNA differences among lines. RAPD markers are useful in studies of genome evolution, analysis of genome composition, and genome identification

The present study was designed to evaluate six promising flax strains and three cultivars released by Fiber Crops Res. Dept. compared with locally commercial cultivar in relation to yield, yield components and technological characters of fiber and oil in addition to some chemical attributes of seeds. Also, to make unique fingerprint for these genotypes.

MATERIALS AND METHODS

This work was conducted at Giza Agric. Res. Station and lab. of seed Technology Dep. Field Crops Res. Instit., ARC during 2007/2008 and 2008/2009 seasons. The flax genotypes included the local cultivar Giza 8, Giza 9, Giza 10, strain 402/10/6 strain 435/11/10/3, strain 12, strain 421/3/6/4, strain 4265/1/3 and strain 1563 (Table 1). The experiments were carried out in randomized complete block design (RCBD) with four replications. Sowing date was in the second week of November in both seasons; the plot size was 10.5 m^2. Plant density of 2500 seeds/m^2 was used and seeds were broadcasted regularly within each plot. Normal cultural practices for flax production were applied as recommended.

Certain quantitative, qualitative morphological and agronomical characters were investigated on seed and maturity plants used as the guidelines for distinctness, homogeneity and stability as the main terms for registration of a new cultivar as defined by International Union for Protection of New Varieties of Plants UPOV (1995) The necessity for such information was to assist the identification of these genotypes in the quality control and certification tests.

At maturity, ten individual guarded plants were taken at random from each experimental plot. Straw, seed, fiber and oil yields/fad were calculated from the hole plot.

Studied Characters

I. Straw yield and its attributes:

1-Total length (cm) 2-Technical length (cm)
3-Stem diameter (mm) 4-Straw weight/plant (g)
5-Straw yield/fad.(ton) 6-Fiber yield/fad. (kg)

2. Seed yield and its components:

1-Upper branching zone length (cm) 2-Number of capsules/plant
3-Seed weight/plant (g) 4- Seed index (g)
5- Seed yield/fad. (kg) 6-Oil yield/fad. (kg).

3. Technological characters:-

Fiber length (cm), fiber percentage (%) and fiber fineness (Nm) were estimated according to Radwan and Momtaz (1966).

4. Laboratory tests: seed vigor and seedling characters

Before starting lab tests, initial moisture content and seed index (weight of 1000 seeds in g.) of each entry were measured.

a- Standard germination: 50 pure seeds of each genotype and three replications were placed in petri dishes containing filter paper soaked with distilled water. The petri dishes were placed in an incubator at 20± 1°C for 7 days. Normal seedlings were counted according to the international rules of ISTA (1993). Germination percentage was calculated using the following formula outlined by Krishnasamy and Seshu (1990).

b-

$$\textbf{Germination (\%)} = \frac{\textbf{Number of normal seedlings x 100}}{\textbf{Number of tested seed}}$$

b- Seed vigor index was calculated using the following formula (Copeland 1976)

$$\textbf{Seed vigor index} = \frac{\textbf{Number of seeds germinated (1}^{\textbf{st}}\textbf{ count)}}{\textbf{Number of days to first count}} + \frac{\textbf{Number of seeds germinated (last count)}}{\textbf{Number of days to last count}}$$

Table 1. Pedigree and plant type (dual purpose, D; oil type, O and fiber type, F) of nine flax genotypes.

Genotype	Pedigree	Type
Giza 9, a newly released cultivar	S. 420/140/5/10 x Bomby	F
Giza 10 a newly released cultivar	S. 420/140/5/10 x Bomby	F
Strain 2468/163	Selection from L Nechua (India)	O
Strain 482/1686	Giza 5 x L 235	D
Giza 8 - Commercial cultivar	Giza 6 x Santa Catalina 6	D
Strain 432/11/883 - Promising strain	S. 162/12 x S. 2467/1	D
Strain 12 - Promising strain	Giza 7 x Bomby	O
Strain 1563 - Promising strain	Imported from Holand	F
Strain 421/3/604 - Promising strain	S. 162/12 x S. 62	D

c- Accelerated ageing germination %: The seeds were kept in an ageing chamber at 45°C and 100 % relative humidity for 3 days. After ageing, the seeds were sun dried. Seed survival percentage was determined by the standard germination test at 20 °C and the mean normal seedling percentage was calculated (AOSA 1983).

d- Electrical conductivity test: The electrical conductivity of the leachate was determined according to procedures described by AOSA (1983). Four sub- samples of 50 seeds of each cultivar were weighed and placed into plastic cups with 250 ml of distilled water, and held at 25°C. After 24 h, the electrical conductivity of the leachates was determined using EC meter. The mean values were expressed in $\mu S\ cm^{-1}g^{-1}$ seed weight.

e- Seedlings characters: Normal seedlings obtained from standard germination test were used for seedling evaluation according to the rules of the Association of Official Seed Analysis (AOSA 1983). Seedling shoot and root length were measured after 7 days of germination test. Twenty-five seedlings from each petri dish were randomly selected and shoot and root lengths of individual seedling were recorded. The shoot and root were also dried at 70 °C for 72 h.

f. Seedling vigor index was calculated using data recorded on germination percentage and seedling growth according to International Seed Testing Association (ISTA 1985) by the formula:

Seedling vigor index = seedling length (cm) X germination percentage

5- Chemical composition: Samples of about 50g of air dried seeds of each genotype finely grounded were randomly chosen from two replications and finely grounded for estimating seeds chemical composition. Crude protein,

total carbohydrates, oil percentage, moisture content ash % and crude fiber % were determined according to the methods of **(AOAC 2000).**

6. Genomic DNA extraction

DNeasy plant minikit (Quigen Inc., Cat.no.69104, and USA) was used for DNA extraction.

RAPD- PCR analysis :

RAPD – PCR reactions were conducted using 5 arbitrary 10- mer primers which were selected from fifteen primers with the 5′ → 3′ sequences as shown in Table 2.

Table 2. Names and sequences of primers that gave bands for RAPD-PCR analysis.

Primer name	Sequence
0P- A09	5′ GGGTAACGCC3′
0P-A16	5′ AGCCAGCGAA3′
0P-B09	5′ TGGGGGACTC3′
0P-B12	5′ CCTTGACGCA3′
0P-C02	5′ GTGAGGCGTC3′

Polymerase chain reaction (PCR) conditions

The reaction conditions were optimized, mixtures and prepared (30µl total volume) consisting of the following.DNTPs 2.4 µl, MgCl2 3.0 µl, 10 x buffer 3.0 µl, Primer (10 um) 2.0 µl, Taq (5u/µl) 0.2 µl,Template DNA (50 ng / µl)2.0 ul, H2O (dd) 17.4 ul. Amplification was carried out in a PTC- 200 thermal cycler (MJ Research, Watertown , USA) programmed as follows : Denaturation, 94 °C for 2 minutes, then for 40 cycles. Each cycle consisted of 1 minute at 94 °C , 1 minute at 37 °C, 2 minutes and 30 second at 72 °C, followed by a final extension time of 12 minutes at 72 °C and 4 °C (infinitive).

7. Gel electrophoresis:

Gel electrophoresis was applied according to Sambrook *et al* (1989). Agarose (1.2 %) was used for resolving the PCR products. The run was performed for one hour at 80 volt in pharmacia submarine (20 x 20 cm). Bands were detected on UV – transilluminator and photographed by Gel documentation 2000, Bio- Rad.

All data were statistically analyzed by the analysis of variance method according to Snedcor and Cochran (1989). Differences between means were tested by L.S.D at the level of 0.05. Bartelett test of homogeneity was adopted indicating no statistical evidence for

heterogeneity thus; combined analysis of variance for genotypes over seasons was worked out.

RESULTS AND DISCUSSION

Seed vigor and seedling characters

Mean values of seed vigor, viability, seedling characteristics and its attributes for nine flax genotype as combined analysis over the two seasons 2007/2008 and 2008/2009 are presented in Table (3).

Table 3. Means of seed vigor and seedling characters for nine flax genotypes (combined data over two seasons).

Genotype	Character							
	Standard germination %	Seed vigor index	Accelerated ageing germination %	Electrical conductivity (μs cm^{-1}g^{-1})	Seedling characters			
					Radical length (cm)	Shoot length (cm)	dry weight (mg)	Seedling vigor index
Giza 9	91.7	36.5	74.2	31.8	3.4	3.4	4.6	631.6
Giza 10	93.2	35.0	75.0	24.6	3.4	3.4	4.3	633.5
Strain 2465/1/3	92..8	37.2	64.7	23.3	3.5	3.8	6.6	671.2
Strain 402/10/6	88.8	35.8	71.0	40.9	3.2	3.6	5.8	604.9
Giza 8	91.3	36.1	66.0	29.6	2.8	2.9	4.2	521.5
Strain 435/11/10/3	91.2	35.3	67.8	30.7	3.4	3.6	5.5	640.9
Strain 12	90.5	36.8	66.8	33.1	3.7	3.3	6.1	635.3
Strain 1563	92.3	36.9	67.8	26.5	3.7	3.6	5.4	673.1
Strain 421/3/6/4	91.3	37.9	66.6	28.4	3.8	3.9	6.6	706.0
L.S.D 0.05%	2.5	1.1	6.6	1.5	0.4	0.5	0.4	51.82

Standard germination percentage of seeds was differed due to the differences between the genotypes of flax (Table 3). It is ranging between 93.2% for Giza 10 and 88.8% for strain 402/10/6. Seed vigor index of strain 421/3/6/4 was 37.9 and for Giza 10 was around 35.0. Accelerated aging germination ranged from 64.7% in strain 2465/1/3 to 75.0% in Giza 10. Electrical conductivity after 24 hours varied among different genotypes. Ec was much higher in Strain 402/10/6 (40.9 μs cm^{-1} g^{-1}) than that of strain 2465/1/3 (23.2 μs cm^{-1} g^{-1}). Higher electrical conductivity of deteriorated seeds was also observed by Schuttle and Leopold (1984) in soybean. There is negative relationship between electrical conductivity and seed germination which indicated that more cell leachates escaped from deteriorated seed and lowered the germination percentage of seed (Table 3).

Seedling characteristics of radical length, shoot length, seedling dry weight and seedling vigor index of flax did not significantly vary (Table 3). The longest radical length was 3.8 cm for strain 421/3/6/4 and for Giza 8 (2.8 cm) was the shortest one. Shoot length was 3.9 cm for strain 421/3/6/4 and was the shortest (2.9 cm) for Giza 8. Strain 421/3/6/4 produced the highest seedling dry weight (6.6 mg) and Giza 8 produced the lowest value (4.2 mg). Seedling vigor index ranged from 521.5 in Giza 8 to 706.0 in (Strain 421/3/6/4). 1000- seed weight ranged from 4.3 g in (Strain 1563) to 9.5g in (Strain 2465/1/3). Such differences in seedling characteristics could be due to the differences in the genetic make- up among the flax genotypes

Morphological characteristics

Data in Table (4) indicated that Giza 9, Giza 10 and strain 1563 had long plant height and stem length, while strain 2465/1/3, strain 402/10/6, Giza 8, strain 435/11/10/3, strain 12 and strain 421/3/6/4 were medium. Results of the flower size of corolla indicated that genotypes can be divided into three main groups: strain 2465/1/3 and Giza 8 were big, strain 402/10/6, strain 435/11/10/3, strain 12 and strain 421/3/6/4 were medium, while the rest of genotypes were small. All genotypes showed absent sepal dotting and present of petal longitudinal. strain 2465/1/3 and Giza 8 were big in ball size, strain 402/10/6, strain 435/11/10/3, strain 12 and strain 421/3/6/4 have medium size, while other genotypes were small in size. 1000- seed weight can be divided into three groups, high (strain 2465/1/3 and Giza8); medium (strain 402/10/6, strain 435/11/10/3, strain 12 and strain 421/3/6/4 and small (Giza 9, Giza 10 and strain 1563). All genotypes have medium time to the begin of flowering. Regarding anther color, strain 1563 had orange anther color; while other genotypes were blue another color. Regarding petal color, two flax genotypes (Giza 9 and Giza 10) have pink petal color, strain 1563 oniontelly color while other genotypes showed blue petal color.

Straw yield and its related characters

Mean values of straw yield and its related characters for the nine flax genotypes as combined over the two successive seasons 2007/2008 and 2008/2009 are presented in Table 5. Results showed significant differences among the nine flax genotypes. Giza 9 surpassed the other genotypes in total length, technical length and straw yield/fad., with mean values of 115.7 cm, 101.8 cm and 4.415 tons, respectively. The highest magnitude of straw /plant was recorded by strain 435/11/10/3 (2.38 g) and the thickness stems were produced by strain 421/3/6/4 (1.362 mm). Concerning fiber yield/fad, Giza 10 gave the maximum yield (901.8 kgs). Moreover, the superiority ratios between the highest and lowest genotypes were 7.5%, 17.3%m, 20.8%, 14.9%, 24.55 and 28.3% for total length, technical length, straw /plant, straw yield/fad., stem diameter and fiber yield/fad., respectively. These differences may be due to the differences in the genetic make -up of

the flax genotypes. Several investigators found significant differences between flax genotypes (Momtaz *et al* 1989, El-Farouk *et al* 2003, El-Shimy and Ashry 2003, Mourad *et al* 2003, El-Kady and Kineber 2004, El-Emary *et al* 2006, El-Sweify *et al* 2006, Mostafa *et al* 2006, Atta *et al* 2007 and Zahana and Abo-Kaied 2007).

Seed yield and its related characters

Table 4. Morphological characters of nine flax genotypes (combined data of two seasons)

Genotype	Character						
	Plant height	Stem length	Flower size	Petal color	Anther color	Boll size	1000 seeds weight
Giza 9	Long	Long	Small	Pink	Blue	Small	Small
Giza 10	Long	Long	Small	Pink	Blue	Small	Small
Strain 2465/1/3	Medium	Medium	Big	Blue	Blue	Big	High
Strain 402/10/6	Medium	Medium	Medium	Blue	Blue	Medium	Medium
Giza 8	Medium	Medium	Big	Blue	Blue	Big	High
Strain 435/11/10/3	Medium	Medium	Medium	Blue	Blue	Medium	Medium
Strain 12	Medium	Medium	Medium	Blue	Blue	Medium	Medium
Strain 1563	Long	Long	Small	Oniontelly	Orange	Small	Small
Strain 421/3/6/4	Medium	Medium	Medium	Blue	Blue	Medium	Medium

Table 5. Mean values of straw yield and its attributes of nine flax genotypes (combined mean over two seasons).

Genotype	Character					
	Total length (cm)	Technical length (cm)	Stem diameter (mm)	Straw weight/plant (g)	Straw yield/fa. (ton)	Fiber yield/fad. (kg)
Giza 9	115.7	101.8	1.094	2.132	4.415	887.7
Giza 10	112.8	97.3	1.125	2.110	4.342	901.8
Strain 2465/1/3	107.6	90.9	1.325	2.254	4.157	703.0
Strain 402/10/6	112.6	95.3	1.211	2.052	4.342	739.4
Giza 8	109.0	90.6	1.304	1.978	4.185	732.6
Strain 435/11/10/3	112.7	94.0	1.261	2.380	4.262	708.2
Strain 12	111.1	90.20	1.344	2.228	4.008	786.2
Strain 1563	112.2	90.3	1.296	1.970	3.843	807.2
Strain 421/3/6/4	108.3	86.8	1.362	2.150	4.310	741.4
L.S.D 0.05	1.431	1.314	0.1704	0.03719	0.3067	6.716

Table (6) shows the combined analysis of the two successive seasons 2007/2008 and 2008/2009 for seed yield and its attributes of the nine flax genotypes. Analysis of variance showed significant differences among genotypes for all studied characters. The promising strain 2465/1/3 ranked first in number of capsules/plant, seed weight/plant, seed yield/fad. and oil yield/fad. followed by Giza 8 cultivar, while strain 1563 outyielded the other genotypes in upper branching zone length. On the other hand, Giza 9 recorded the lowest mean value of upper branching zone length and strain 435/11/10/3 gave the maximum estimate for seed weight/plant. Moreover, strain 1563 was the latest genotype concerning number of capsules/plant, seed index, seed yield/fad. and oil yield/fad. The superiority ratios between the maximum and minimum estimates were 58.7%, 170.9%, 44.8%, 120.2%, 93.55 and 110.7% for upper branching zone length, number of capsules/plant, seed weight/plant, seed index, seed yield/fad. and oil yield/fad., respectively. It is clear that the flax genotypes significantly differed in seed yield and its related characters according to the differences in their genetic structure. Similar results were observed by Momtaz *et al* (1989), El-Farouk *et al* (2003), Mourad *et al* (2003), El-Kady and Kineber (2004), El-Emary *et al* (2006), El-Sweify *et al* (2006), Mostafa *et al* (2006), Atta *et al* (2007) and Zahana and Abo-Kaied (2007).

Table 6. Mean values of seed yield and its attributes of nine flax genotypes (combined mean over two seasons).

Genotype	Character					
	Upper. branching zone length (cm)	No. capsule /plant	Seed weight/ plant (g)	Seed index (g)	Seed yield/fad. (kg)	Oil yield/fad. (kg)
Giza 9	13.8	13.75	0.422	4.645	469.0	166.6
Giza 10	15.6	12.83	0.392	5.320	460.3	160.1
Strain 2465/1/3	16.7	34.42	0.533	9.463	739.7	303.4
Strain 402/10/6	17.1	24.00	0.470	8.853	691.2	266.6
Giza 8	18.6	31.25	0.507	9.240	718.7	292.9
Strain 435/11/10/3	18.6	22.42	0.368	8.165	616.0	241.5
Strain 12	20.2	24.17	0.468	8.537	687.0	271.5
Strain 1563	21.9	12.67	0.383	4.298	382.3	144.0
Strain 421/3/6/4	21.5	21.58	0.443	8.348	665.8	263.7
L.S.D 0.05%	2.354	2.62	0.291	0.67	4.28	2.55

Chemical composition of seeds

The variations in the chemical components of flax seeds are mainly related to genotypes, planting date, location, soil structure, crop maturity and other environmental conditions.

Whole flax seed of the nine genotypes were analyzed for their chemical composition. The results are shown in Table (7). Crude protein of different flax seed genotypes ranged between 21.54% (strain 2465/1/3) to 24.25% (Giza10). In addition, Giza 10 gave the highest total carbohydrates (24.69%) but Giza 8 gave the lowest percentage (22.78%).. These results are in agreement with those obtained by El-Ghobashy *et al* (2002), Hall (2003) and Abd El-Rhanan (2005).

Table 7. Chemical characteristics of nine flax genotypes (combined means over two seasons).

Genotype	Character					
	Crude protein %	Total carbohydrates %	Oil %	Moisture content %	Ash %	Crude fiber %
Giza 9	23.98	24.38	35.53	6.45	3.87	5.79
Giza 10	24.25	24.69	34.78	6.29	4.18	5.81
Strain 2465/1/3	21.54	24.34	41.02	6.04	3.39	3.67
Strain 402/10/6	23.33	23.57	38.58	6.93	4.63	4.96
Giza 8	22.37	22.78	40.76	6.31	3.49	4.29
Strain 435/11/10/3	22.91	23.96	39.20	6.19	3.43	4.31
Strain 12	23.21	23.79	39.47	6.06	3.59	3.88
Strain 1563	23.38	23.95	37.65	6.30	3.58	5.13
Strain 421/3/6/4	23.23	23.55	39.6	6.17	3.74	3.71
L.S.D 0.05	0.17	0.36	0.26	0.17	0.21	0.50

Results in Table (7) also showed that S2465/1/3 surpassed the other genotypes for seed oil percentage (41.02%), whereas the lowest value 34.78% was recorded for Giza 10. These results are in agreement with those obtained by Kineber and El-Sayed (2004) and Naguib (2006). In addition, results in Table 6 show that seed moisture percentage ranged from 6.04 (S2465/1/3) and 6.93% (Strain 402/10/6), while, the ash percentage ranged between 3.39 (Strain 2465/1/3) and 4.63% (Strain 402/10/6). Crude fiber content ranged between 3.88% (Strain 12) and 5.81% (Giza 10). These results are in agreement with those obtained by El- Sayed *et al.*, (2004), \Abo El- Rhaman (2005) Naguib (2006).

Fiber technological characters

Average of fiber technological characters of the nine flax genotypes as combined analysis over two seasons are presented in Table (8). Flax genotypes exhibited significant differences concerning the technological traits. Regarding fiber length, Giza 9 surpassed the other genotypes and gave fiber with 99 cm length and the lowest one was strain 421/3/6/4 (83.8 cm).

Table 8. Mean values of technological characters of nine flax genotypes (combined means over two seasons).

Genotype	Character		
	Fiber length (cm)	Fiber percentage	Fiber fineness (Nm)
Giza 9	99.00	20.11	180.7
Giza 10	94.83	20.92	174.0
Strain 2465/1/3	89.00	16.91	161.3
Strain 402/10/6	93.00	17.03	162.5
Giza 8	87.25	17.51	164.8
Strain 435/11/10/3	91.42	16.62	151.8
Strain 12	87.00	19.61	152.5
Strain 1563	87.42	21.00	167.0
Strain 421/3/6/4	83.75	17.20	151.7
L.S.D 0.05	1.203	0.06	2.013

Concerning fiber percentage, it is clear that the mean values ranged from 16.62% for strain 435/11/10/3 to 21.0% for strain 1563 and the rest of genotypes ranked intermediate. In respect with fiber fineness, results indicated that Giza 9 ranked first with 180.7 Nm, followed by Giza 10 of 174 Nm, strain 1563 (167 Nm), Giza 8 (164.8 Nm), strain 402/10/6 (162.5 Nm), strain 2465/1/3 (161.3 Nm0, strain 12 (152.5 Nm), strain. 435/11/10/3 (151.8) then came lately strain 421/3/6/4 of 151.7 Nm. The present results are mainly due to the differences in genetical constitution of the tested genotypes under study. These results are in harmony with those obtained by Momtaz *et al.*, (1989), El-Shimy and \Ashry (2003), Mourad *et al.*(2003), El-Kady and Kineber (2004), El-Sweify *et al* (2006), Mostafa *et al* (2006), Atta *et al* (2007) and Zahana and Abo-Kaied (2007).

Molecular Marker

Out of fifteen primers, we selected five 10-mer primers (Table2), which revealed the highest level of polymorphism between the nine flax genotypes. These primers produced multiple bands, which ranged between 5 bands for primer OP-B09 to 15 bands for primer OP-C02. The total number of bands amplified by these primers were 43 bands, 34 bands of them were polymorphic. The highest level of polymorphism could be observed in primer OP-B09 which showed 100% polymorphism while the lowest level of polymorphism was 60% in primer OP-A16 (Table 9).

The genetic similarity matrix based on RAPD analysis ranged between 94 % and 56%. The highest similarity (94%) was between strain 12

Table 9. Levels of polymorphism and unique genotype-specific bands based on PAPD analysis.

Bands / Primer	Total bands	Polymorphic bands	Monomorphic bands	% Polymorphism	Unique bands	
					Genotype	MS
OP-A09	7	6	1	86	Giza 9 Giza 9 Strain 402/6/10	1057bp 899bp 282bp
OP-A16	10	6	4	60	Giza 10	439bp
OP-B09	5	5	0	100	Giza 9	922bp
OP-B12	6	4	2	67	Giza 9	1573bp
OP-C02	15	13	2	87	Giza 8 Strain 4/6/3/421	167bp 525,344
Total	43	34	9			

and strain 2465/1/3, while, the lowest similarity (56%) was between Giza 8 and Giza 9 as shown in Table (10).

The dendrogram based on RAPD analysis (Figure 1) separated the studied genotypes into two main clusters, the first cluster included Giza 8, Giza 10, strain 12, strain 1563, strain 2465/1/3, strain 435/11/10/3, strain 421/3/6/4, strain 402/6/10 while, Giza 9 was in a separate cluster.

RAPD analysis can detect polymorphism and could discriminate between all the nine genotype. This is in agreement with Williams *et al* (1990).

RAPD also can produce a large set of markers. The highest number of markers was observed in Giza 9, which recorded four unique markers, bands at 1057 and 899bp of primer OP-A09, the band at 922 bp of primer OP-B09 and the band at 1573 bp of primer OP-B12. Also, strain 4/6/3/421 has two unique markers at 525 bp and 344 bp of primer OP-C02 and there is one unique marker for each of Giza 8, Giza 10 and strain 402/6/10 at 167 bp of primer OP-C02, 439 bp of primer OP-A16 and at 282 bp of primer OP-A09, respectively, as shown in Table (10).

Table 10. Similarity matrix among the nine flax genotypes based on RAPD analysis.

	Giza8	Giza9	Giza10	Strain12	Strain-1563	Strain-2465/1/3	Strain-435/11/10/3	Strain-421/3/6/4	Strain-402/6/10
2	.566								
3	.800	.600							
4	.815	.612	.941						
5	.680	.667	.766	.826					
6	.836	.640	.885	.941	.809				
7	.842	.615	.889	.906	.735	.926			
8	.612	.591	.652	.711	.683	.739	.708		
9	.680	.667	.766	.783	.714	.809	.816	.780	

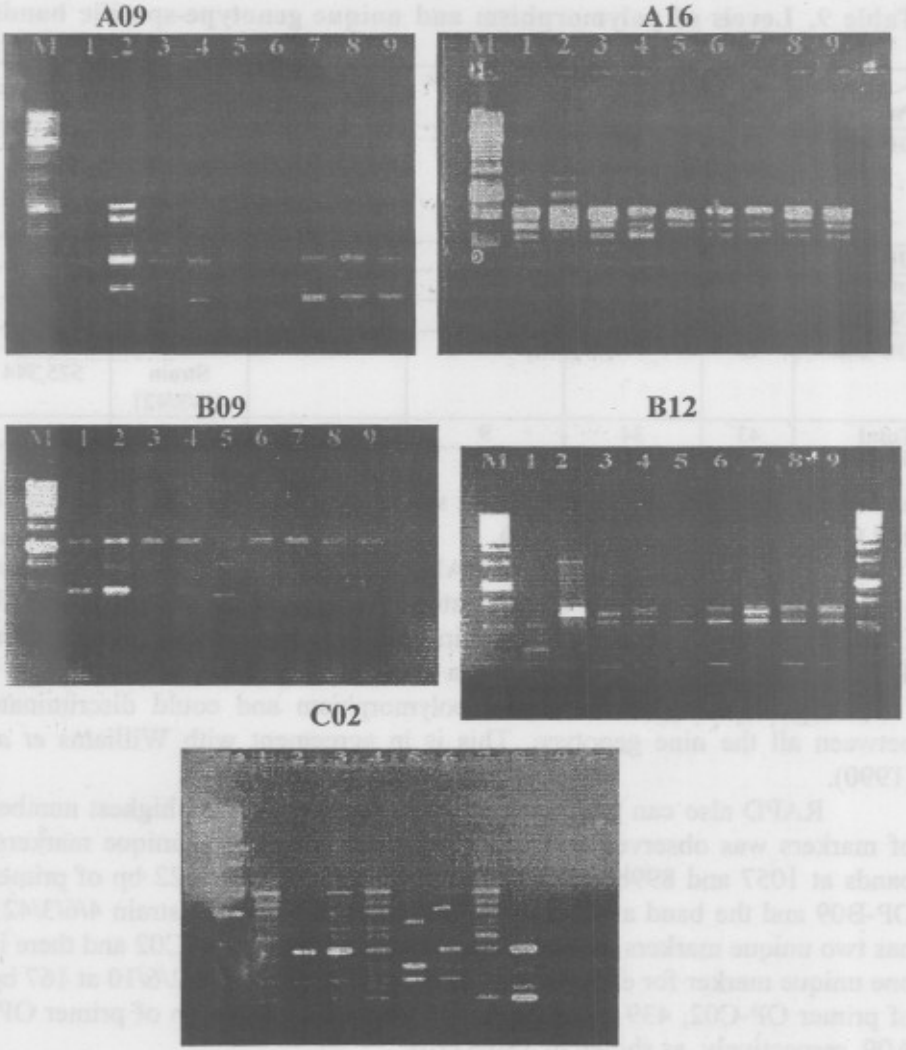

Fig. 1. RAPD fingerprinting of the nine flax genotypes using five primers (A09, A16, B09, B12,C02) genotypes from 1to 9 are: Giza 8, Giza9, Giza 10, strain 12, strain 1563, strain 2465/1/3, strain 435/11/10/3, strain 421/3/6/4, strain 402/6/10 .

REFERENCES

Abd El-Rhaman E.I. Hanaa (2005). Biochemical studies on Linseed oil PhD .Thesis, Fac. Of Agric., Cairo Univ.,

AOAC (2000). Official Methods of Analysis, of the Association of Official Analytical Agricultural Chemists, 17 th ed. Published by A.O.A.C.

AOSA (1983). Seed vigor testing handbook. Contribution No. 32 to Handbook on seed testing. Association of Official Seed Analysts, pp:88-93.

Atta, Y.I.M., M.M.M. Hussein and A.A. Nassar (2007). Some factors affecting linseed (*Linum usitatissimum* L.) yield, quality and water use efficiency. Zagazig J. Agric. Res. 34 (4): 617-642.

Copeland, L.O.(1976). Principles of Seed Science and Technology. Burgess Pub. Com., Minneapolis, Minnesota, USA,.

Dornbos, D.I. (1995). Seed vigor. In. Seed Quality: Basic Mechanisms and Agricultural Implications. (Ed. A.S.Basra) Food product Press, New York, pp:45-80.

El-Emary, F.A., M.F. El-Nady and A.A. Abdel-Fatah (2006). Botanical studies on some dual purpose falx (*Linum usitatissimum* L.) genotypes grown under Egyptain delta conditions.) Proc. The First Field Crops Conference, (Giza) Egypt. 22-24 August P. 490-501.

El-Farouk, M., E.A.F. El-Kady, A.M. Hella, M.E.A. Kineber, N.K.M. Mourad, S.H. Mostafa, S.Z. Zedan; Eman A. El-Kady and T.A. Abou Zaied (2003). Releasing of two New flax varieties " Sakha 1" and "Sakha 2".Fayoum J. Agric. Res & Dev. 17 (2): 1-8.

El- Ghobashy, A.K., H.Y.M. Youssef, M.M. Dalia and S.Z. Zedan (2002) Effect of different locations on chemical composition and fatty acids in the seeds of eight flax cultivars. Zagazig J. Agric. Res., vol 29 No. (6) 1805-1814.

El-Kady, E.A. and M.E.A. Kineber (2004). A comparative study on some flax genotypes. J. Agric. Res. Tanta Univ. 30 (3): 587-600.

Ellis, R. H. (1992). Seed and seedling vigor in relation of crop growth and yield.Plant Growth Regul. 11: 249-255.

El- Sayed A. Soad, M.E.A. Kineber and Eman A. El-Kady (2004). Effect of storage environment and package material on storability, yield and its quality of flax seeds. J. Agric. Res. Tanta Univ. 30 (3): 616-638.

El-Shimy, G.H. and Ashry Naglaa (2003). Analysis of yield components and genetic parameters in some flax crosses. J. Agric. Res. Mansoura Univ. 28 (4): 2505-2514.

El-Sweify,H.H. Amna, M.A. Abd El-Dayem and M.M.M. Hussein (2006). Response of some flax genotypes to pulling date under newly reclaimed sandy soil and sprinkler irrigation conditions. Egypt J. Agric. Res. 84 (4):1103-1115.

Hall, R. (2003). Seeds, Flax seed (1). J. Biol. Chem., 277(35) : 23120.

ISTA (1985). International Seed Testing Association. International rules for seed testing Proc. Int. Seed Test. Assoc. 31: 1-52.

ISTA (1987). International Seed Testing Association Handbook of Vigor Test Methods. 2nd Ed., International seed testing Association, Zurich, Switzerland.

ISTA (1993) International Seed Testing Association. International Rules for Seed Testing. Seed Sci. and Technol., 21:187-209.

Karp, A., O. Seberg and M. Buitti (1996). Molecular techniques in the assessment of botanical diversity. Ann. Bot. 78: 143 – 149.

Kineber, M.E.A. and Soad A. El- Sayed. (2004). Studies on some economic characteristics in flax (*Linum usitatissimum* L.) in north delta region of Egypt .Annals Agric. Sci., Ain Shams Univ., Cairo. 49 (1). 71-81.

Krishnasamy, V. and D.V. Seshu. (1990). Germination after accelerated ageing and associated characters in rice varieties. Seed Sci . Technol. 18: 147-156.

Lee, M. (1995). DNA markers and plant breeding programs. Adv. Agron. 55: 265-344.

Malcolmson, L. J., R. Przybylski and J. K. Daun (2000). Storage stability of milled flaxseed . J. Am. Oil Chem. Soc. 77 (3): 235.

Momtaz, A., M. El-Farouk, N.K. mourad, T. Nasr El-Din, E.A.F. El-Kady and A.M.A. Hella (1989). New flax varieties Giza 7 and Giza 8. Agric Res. Rev. 68 (7): 1461-1475.

Mostafa, S.H., Amal H. Selim and M.N. Abd-ElAziz (2006). Morphological, biochemical and agronomical identification of some flax (*Linum usitatissimum* L.) genotypes. Proc. The First Field Crops Conference, (Giza) Egypt. 22-24 August. P. 223-231

Mourad, N.K.M., S.H.A. Mostafa and Afaf. E. A.Zahana (2003). Yield, yield components, quality and variability assessment of some flax genotypes. Egypt J. Plant Breed. 7 (2): 129-142.

Naguib A. Nemat (2006). Evaluation of seed quality of different flax seed genotypes (*Linum usitatissimum* L.). Proc.The First Field Crops Conference (Giza) Egypt 22-24 August. 481-489

Perry, D.A., (1989). Handbook of Vigor Test Methods 2 nd Ed. ISTA, Zurich, Switzerland.

Radwan, S.R.A and A., Momtaz (1966). The technological properties for flax fiber and the methods of estimating them. El-Felaha J. 46 (5): 466-476.

Saeidi, G. (2008). Genetic variation and heritability for germination seed vigour and field emergence in brown and yellow-seed genotypes of flax. International J. of Plant Production 2 (1): 1-7.

Sambrook, J., E. F. Fritsch and T. Maniatis (1989). Molecular cloning. A Laboratory manual, Second Edition. Volume 1.

Schuttle, A. W. and A.C. Leopold. (1984). Solute leakage from artificially aged soybean seed after imbibition. Crop Sci., 24: 835- 838.

Snedecor, G.W. and W.G. Cochran (1989). Statistical Method. 8 th. Edition, Iowa State Univ., Press. Ames., Iowa, USA.

UPOV (1995). The International Union for the Protection of New Cultivars of Plants: Guidelines for the conduct of tests for distinctness, uniformity and stability for flax. Descriptor No., TG/57/6.

Williams, J.G.K., A.R. Kubelik, K.J. Livak, J.A. Rafalski and S.V. Tingey (1990). DNA polymorphism amplified by arbitrary primers is useful as genetic markers. Nucleic Acids Research 18: 6531-6535.

Zahana, Afaf E.A. and H.M.H. Abo-Kaied (2007). Response of some flax genotypes to different mineral nitrogen levels and bio-fertilizer. J. Agric. Sci. Mansoura Univ. 32 (3): 1639-1648.

تقييم بعض الصفات الكمية والوصفية لتسعة تراكيب وراثية من الكتان

صابر حسين مصطفى١، عزيزه محمد حسنين٢ ، نعمت عدلى نجيب٢

١- قسم بحوث محاصيل الالياف- معهد بحوث المحاصيل الحقلية- مركز البحوث الزراعية- الجيزه

٢-قسم بحوث تكنولوجيا البذور - - معهد بحوث المحاصيل الحقلية- مركز البحوث الزراعية- الجيزه

يعتبر تقييم صفات جودة البذور فى الكتان من الأهداف الهامة فى برنامج التربية. لذا أجريت تجربتان حقليتان بمحطة البحوث الزراعية بالجيزة خلال موسمى الزراعة 2008/2007 ، 2009/2008 بالإضافة إلى التجارب المعملية بقسم بحوث تكنولوجيا البذور لتقدير بعض الصفات الحيوية والكيميائية والبيوتكنولوجية.و تم تقييم تسع تراكيب وراثية هى (جيزة /8 ، جيزة /9 ، جيزة /10 ، سلالة /10/6/402 ، سلالة 3/10/11/435، سلالة /12، سلالة 4/6/3/421 ، سلالة 3/1/4265 ، سلالة /1563)، وذلك بهدف تمييزها وتقييمها مورفولوجيا ومحصوليا وبيوكيميائيا والتى تعتبر من المتطلبات الاساسية لتسجيل الاصناف النباتية وحماية حقوق مربى النباتات.

وقد امكن أستخدام بعض الصفات المورفولوجية والمحصولية فى تمييز التراكيب الوراثية المبشرة فى حين لم يف أستخدام هذه الصفات فى تمييز حالات أخرى حيث أظهرت كل الأصناف المختبرة نسب إنبات عالية تراوحت ما بين93.2% (جيزة /10) الى88.8 % (سلالة 6/10/402) ، فى حين تراوحت نسب الإسراع بالشيخوخة بين64.7% (سلالة 3/1/2465) الى 75% (جيزة 10) ، وفى نفس الوقت سجلت السلاله 6/10/402 أعلى قيمة من التوصيل الكهربي (40.9 ميكروسيمون/سم/جم) بينما سجل الصنف 3/1/2465 اقل قيمة (23.24 ميكروسيمون/سم/جم). وكانت الاختلافات بين صفات البادرات مثل طول الجذير وطول الريشة والوزن الجاف للبادرات ودليل قوة البذور ضعيفة وغير واضحة .و فيما يتعلق بمحصولى القش والبذور وصفاتهما المرتبطة والصفات التكنولوجية أظهرت الدراسة اختلافات واضحة فى الصفات المظهرية بين التراكيب الوراثية تحت الدراسة. أحتل التركيب الوراثى جيزة 9 المرتبة الأولى فى الطول الكلى، الطول الفعال، محصول القش للفدان، محصول الألياف للفدان، طول الألياف ونعومتها. بينما تفوقت السلالة 3/10/11/435 على باقى التراكيب الوراثية فى وزن القش للنبات وفى نفس الوقت سجلت السلالة 4/6/3/421 أعلى القيم لسمك الساق وأعطت

السلالة ٣/١/٢٤٦٥ أكبرالقيم لعدد كبسولات النبات، وزن البذور للنبات، دليل البذور، محصول البذور للفدان، النسبة المئوية للزيت بالبذور، محصول الزيت للفدان. وكانت السلالة ١٥٦٣ الأكثر طولا فى المنطقة الثمرية. وقد تفوق التركيب الوراثى جيزة١٠ على باقى التراكيب الوراثية فى النسبة المئوية للألياف.

أوضحت النتائج وجود اختلاف بين التراكيب الوراثية فى التركيب الكيماوي وتراوحت النسبة المئوية للبروتين ما بين٢١,٥% التركيب الوراثى٢٤٦٥/ ٣/١ الى ٢٤,٣ % (جيزة ١٠)، سجل صنف جيزة ٨ اقل نسبة من الكربوهيدرات (٢٢,٨%) بينما كانت أعلى نسبة (٢٤,٧%) للصنف جيزة ١٠وتراوحت النسبة المئوية للزيت ما بين ٣٤,٨ % (جيزة ١٠) الى ٤١,٠٢% (السلالة ٣/١/٢٤٦٥)

تم استخدام تكنيك التكبير العشوائي المتعدد الصور للحامض النووي (RAPD-PCR) لعمل البصمة الوراثية للتراكيب الوراثية التسعة لتسعة تراكيب وراثية من الكتان باستخدام خمسة بادئات عشوائية. هذا التكنيك اظهر اختلافاً بين هذه التراكيب الوراثيه و الحصول على بصمة وراثيه لكل تركيب وراثى. وقسمت الشجرة التطورية هذه التراكيب الوراثيه الى مجموعتين المجموعة الأولى تضم الصنف جيزة ٩ فقط أما باقى التراكيب فكانت تنتمى الى المجموعة الثانية، كما وجد ان اعلى درجة تشابه كانت بين السلالة ١٢ والسلالة ٣/١/٢٤٦٥ بينما وجد ان اقل درجة تشابه كانت بين جيزة ٨ و جيزة ٩ . وتعتبر النتائج المتحصل عليها من هذه الدراسة ذات أهمية كبيرة فى حفظ حقوق مربى النباتات عند تسجيل التراكيب الوراثية المبشره كأصناف تجارية جديدة الا انه على مربى النباتات الانتخاب من قاعدة وراثية عريضة حتى يمكن الحصول على صفات مورفولوجية مميزة للسلالات الجديدة عن الاصناف المنزرعة عند تسجيلها كأصناف جديدة مما يسهل التحقق من نقاوة الصنف الجديد أثناء مراحل اكثاره المختلفة.