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EFFECT OF PLANT DENSITY AND POTASSIUM FERTILIZER ON YIELD AND ITS QUALITY OF SOME FLAX GENOTYPES UNDER SANDY SOIL CONDITIONS

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ABSTRACT

Two field experiments were carried out at Ismailia Agric. Res. Station Farm, Ismailia Governorate, Agric. Res. Center (A.R.C.), Egypt during the two successive seasons of 2004/05 and 2005/06 to study the effect of three plant densities *i. e.* 1500, 1750 and 2000 seeds/m^2 and three potassium levels 24, 48, and 72 kg of k2o/fad.on the flax genotypes namely Belinka, Sakha1 and S. 2465/3 regarding straw and seed yields in addition to their related characters and the interrelationships among different traits under sandy soil conditions.

Results obtained can be summarized as follow:

1- Belinka variety significantly surpassed the other flax genotypes which produced the highest values of total and technical length per plant, fiber yield per fad, fiber length, fiber percentage and fiber fineness, while Sakha1, variety produced the highest values of straw yield per plant, straw yield per fad. and biological yield per fad. However, the promising strain 2465/3 produced the highest values of main stem diameter, fruiting zone length, number of fruiting branches per plant, number of capsules per plant, number of seeds per capsules, 1000-seed weight, seed yield per plant as well as per fad, seed oil percentage and oil yield per fad.

2- There was a significant increment with increasing plant densities from 1500 seeds up to 2000 seed/m^2 in most characters studied of straw and seed yields, but stem diameter, straw yield per plant, fruiting zone length, number of fruiting branches per plant, number of capsules per plant, number of seeds per capsule, seed yield per plant and seed oil percentage were decreased significantly as plant density increased. This was true in the two seasons.

3- Applying of potassium fertilizer levels caused significant increase for straw and seed yield characters except with fiber fineness and fruiting zone length which tended to decrease gradually with increasing potassium level.

4- Straw yield per fad. correlated positively and highly significant with straw yield per plant, fiber yield per fad., fiber length, seed yield per fad., oil yield per fad. And 1000-seed seed weight. The correlation coefficient values between seed yield per fad. and each of oil yield per fad., 1000-seed weight and number of capsules per plant were significant and positive.

INTRODUCTION

Flax (*Linum usitatissimum* L.) is one of the oldest fiber crops. It has been cultivated by ancient Egyptian people since several years ago. It is grown in different regions of the world for fiber and seed production. It is known in Egypt as a dual purpose type for its tow products *i.e*., fiber and seeds, where the fiber locally used in textile industry and the excess of it export abroad by hard currency. Linseed oil used as a food for human and the boiling oil used in paint and varnish industry. Improving and increasing yield of flax either seed or fiber are of great interest for flax producer and could be achieved throughout firstly cultivating best flax varieties characterized by high yielding ability and secondly by applying favourable agricultural treatment for flax production like plant density and potassium

fertilizer level. Studies had been reported the differences between flax genotypes by many investigators who noticed that flax genotypes differed significantly from each other. Among of them, Momtaz *et al*, (1990), El-Kady *et al*,(1995), El-Sweify and Mostafa (1996), Mostafa *et al*, (1998), El-Shimy and Moawed (2000), Al-Kaddossi and Moawed (2001) and Mostafa (2003).

Many investigators studied the effect of plant density on flax plants such as Momtaz and Shalaby (1981), El- Kady *et al,* (1995), El-Sweify and Mostafa (1996), Stevenson and Wright (1996), Mostafa *et al*, (1998), Abdel-Wahed (2002) and Zedan (2004).

Potassium play a great role in plant growth as a result of affecting many physiological processes in the plant cell as enzymes activity, respiration, photosynthesis, chlorophyll creation, water amount in leaves and to regulate stomata opeining. So, several investigators reported that fertilized flax plants with potassium cased an increase in productivity and quality of fiber and oil among them, Sudakov *et al,* (1992), Zedan *et al,* (1997), Nassar and El-Taweel (2001), Hussein (2002) and El-Azzouni *et al,* (2003).

Correlation is an important statistical estimation which use to serve breeding programs for determiming the best characters which more affected each of straw and seed yields. Correlation had been studied by several workers such as Momtaz *et al,* (1977), Al-Kaddousi and Moawed (2001).

The aim of this investigation was to study the effect of plant density, potassium fertilizer on yield and quality of some flax genotypes under sandy soil conditions.

MATERIALS AND METHODS

Two field experiments were carried out at Ismailia Agric. Res. Station, Agric. Res. Center during the two successive seasons 2004/05 and 2005/06. A split-split plot design with four replications was used. The main plots were devoted to the three flax genotypes which included Sakha1 variety (G1), strain 2465/3 (G2) and Belinka (G3). The sub-plots were assigned to the three plant densities *i. e*., 1500 (D1), 1750 (D2) and 2000 seeds / m^2 (D3) and the three potassium levels i.e., 24 (K1), 48 (K2) and 72 K_2O / fad (K3) were confirmed to the sub- sub plot. Each sub- sub plot was 3m long 2m wide {1/700 fad (faddan=4200m^2)}. The soil of the experimental site was sandy. The mechanical and chemical analysis of soil are given in Table (1).

Flax variety Sakha1and the promising strain 2465/3 were selected from cross between Bombay x 1.1485, and selection from Neelum (I. Indian), respectively. In addition to Belinka variety a fiber type was imported from Holland. Seeds were sown in November 18th and 21st in the two season, respectively. The drilling method was used at 15 cm apparent between rows. All plots received 100 kg / fad of calcium super-phosphates (15.5% p_2o_5) before sowing. Potassium sulphate (48% K_2o) using the mentioned levels were applied to the soil during preparing of the experimental soil. Nitrogen fertilizer in the form of ammonium nitrate (33.5%N) was added at a rate of 75 kg N / fad in four equal doses after 15, 30, 45 and 60 days from sowing. These fertilizers were added in each of the

two successive seasons. The preceding crop was *Zea maize* in both seasons. All other normal cultural practices of growing flax at Ismailia Governorate were followed. At harvest time ten guarded plants were taken randomly from each plot to measure the following characters:

Table (1): The Mechanical and chemical characteristics of experimental soil at Ismailia Agricultural Research Station during 2004/05 and 2005/06 seasons.

Variables	Seasons	
	2004/05	2005/06
	Mechanical analysis	
Soil type	Sandy	Sandy
Coarse sand %	73.8	74.2
Fine sand %	18.7	17.8
Silt %	2.2	3.1
Clay%	5.3	4.2
	Chemical analysis	
PH value in 1: 2.5 suspension	8.1	7.9
EC (mhos/cm) dsm^{-1}	0.65	0.480
Organic matter %	0.6	0.4
Total nitrogen	0.038	0.022
Cations (meg/L):-		
Ca++	1.30	1.42
Mg++	1.82	1.94
Na++	0.72	0.63
K+	0.08	0.07
Anions (meg/L):-		
$CO3^-$	0.00	0.00
$SO4^-$	0.59	0.48
CL^-	1.75	1.60

Straw yield and related characters: Total length / plant (cm), technical stem length (cm), main stem diameter (mm), straw yield (g) / plant, straw yield / fad, biological yield (ton) / fad, fiber yield (ton) / fad, fiber length (cm), fiber percentage and fiber fineness (Nm).

Seed yield and related characters: fruiting zone length (cm) / plant, number of fruiting branches / plant, number of capsules / plant, number of seeds / capsule, 1000-seed weight (g), seed yield (g) / plant, seed yield (kg) / fad, seed oil percentage and oil yield (kg) / fad.

STATISTICAL ANALYSIS

All data were statistically analyzed by the analysis of split- split plot design was used according to Snedecor and Cochran (1982) and differences between means were tested by L.S.D. at the levels of 0.05 and 0.01.

Correlation studies:

Estimates of correlation coefficient (r) between different flax characters were calculated according to Svab (1973) as follow:

$r = SP_{XY}/(SS_X.SS_Y)^{0.5}$ Where:

$SP_{XY} = \sum_{xy} - (\sum x - \sum y/n)$
$SS_X = \sum x^2 - ((\sum x)^2 /n)$
$SS_Y = \sum Y^2 - ((\sum Y)^2 /n)$

RESULTS AND DISCUSSION

I - Straw yield and its related characters:

Data in Tables ($2_{a,b}$) showed the mean values of straw yield and its related characters for the three flax genotypes (G) as affected by plant density (D), potassium fertilizer levels (K) and their interactions in the two successive seasons 2004/2005 and 2005/2006. Analysis of variance showed significant differences in all ten characters studied concerning the flax genotypes and either plant density or potassium levels in both seasons.

1-1- Genotypes performance:

Data showed that flax variety Belinka ranked first and surpassed significantly the two other ones in total length / plant, technical length / plant, fiber yield / fad, fiber length, fiber percentage and fiber fineness which recorded (91.06 and 92.99 cm), (84.62 and 85.86 cm), (0.509 and 0.525 ton), (86.19 and 87.99 cm), (20.28 and 20.40 %) and (220.60 and 230.11Nm) for the same characters arrangement in both seasons, respectively. Meanwhile, the flax variety Sakha1 achieved maximum estimates for straw yield / plant (1.332 and 1.680 gm), straw yield / fad (3.041 and 3.073 ton), biological yield / fad (3.518 and 3.598 ton) and ranked second in relation to fiber yield / fad (0.502 and 0.524 ton). On the other hand, the promising strain 2465/3 recorded the lowest mean values of total length (74.39 and 77.83 cm), technical length (59.89 and 63.67 cm), fiber length (71.32 and 71.71 cm), fiber percentage (14.18 and 14.51%) and fiber fineness (190.26 and 199.20Nm). Data showed also that the strain 2465/3 gave the highest values of main stem diameter (2.45 and 2.80mm) when compared with the two flax varieties Sakha1 and Belinka in both seasons, respectively. These results were mainly due to the genetical make up of each flax genotypes under this study. These results are in agreement with those obtained by Momtaz *et al* (1989), Mostafa *et al* (1998), El-Shimy and Moawed (2000), El-Azzouni *et al* (2003), Mostafa (2003) and Zedan (2004).

1-2- Effect of plant density:

Concerning to plant density, results obtained revealed that total and technical length / plant, straw yield / fad, biological yield / fad, fiber yield / fad, fiber length, fiber percentage and fiber fineness were significantly increased with increasing plant density from 1500 through 2000 seeds / m^2. The respective mean values which recorded by the highest plant density (2000 seed / m^2) were 84.63 and 87.43 cm, 74.96 and 77.90 cm, 2.947 and 3.051 ton, 3.429 and 3.60 ton, 0.515 and 0.538 ton, 81.25 and 82.55 cm, 17.30 and 17.70% in addition to 211.65 and 219.15 Nm for the above mentioned characters, respectively. Meanwhile, the two characters i.e., main stem diameter and straw yield / plant toke the opposite direction, by means that the maximum averages obtained as a result of the lowest plant density (1500 seeds/m^2).

T2

T2

The two plant densities 1750 and 2000 seeds / m^2 did not differ significantly for straw yield / fad, biological yield / fad and fiber yield / fad in both seasons but fiber length in both seasons and fiber percentage was similar in only the first season. Moreover, the second plant density (1750 seed / m^2) achieved intermediate estimates in relation to the ten straw characters under study. It must be mentioned that the great number of flax plants per unit area for highest plant density caused an increment in averages of the eight characters previously mentioned. These results are in a good line with those obtained by Momtaz *et al* (1981), El-Kady *et al* (1995), El-Sweify and Mostafa (1996), Stevenson and Wright (1996), Mostfa *et al* (1998), Abdel-Wahed (2002) and Zedan (2004).

1.3- Effect of potassium fertilizer levels:

Data indicated clearly that straw yield and its related characters *i.e.* total and technical length / plant, main stem diameter, straw yield / plant, straw yield / fad, biological yield / fad, fiber yield / fad, fiber length and fiber percentage tended to increase gradually with increasing the rate of potassium fertilizer level up to the highest level (72 kg K_2O / fad) in both seasons. The differences between the two potassium level *i. e.* 48 and 72 kg K_2O / fad did not reache the level of significance for straw yield / fad in the two successive seasons. However gradual decrement had been observed in fiber fineness due to increasing potassium fertilizer level up to 72 kg k_2O / fad. These results are in agreement with those obtained by El-Sweify and Mostafa (1996), Zedan *et al* (1997), Hussein (2002) and El-Azzoni *et al* (2003).

2- Seed yield and its related characters:

Mean values of nine characters i.e. fruiting zone length, number of fruiting branches, number of capsules / plant, number of seeds / capsule, 1000-seed weight, seed yield / plant, seed yield / fad, seed oil percentage and oil yield / fad of flax genotypes as affected by plant density and potassium fertilizer levels and their interactions in the two successive seasons 2004/05 and 2005/06 are presented in tables ($3_{a,b}$). Statistical analysis showed significant differences in all nine characters studied between flax genotypes and between either plant densities or potassium levels in both seasons.

2-1- Genotypes performance:

It is clearly evident that the promising strain 2465/3 ranked first and recorded the highest estimates in seed yield and its related characters with the mean values of 14.61 and 14.08 cm, 10.44 and 11.21, 7.94 and 9.23, 8.26 and 8.89, 9.33 and 10.09 g, 0.410 and 0.506 g, 589.57 and 639.41kg, 40.01 and 40.16% and 235.79 and 256.73 kg for fruiting zone length, number of fruiting branches, number of capsules / plant, number of seeds / capsule, 1000-seed weight, seed yield / plant, seed yield / fad, seed oil percentage and oil yield / fad in both seasons, respectively. While sakha 1 variety ranked second in this respect with the mean values of 11.13 and 10.10cm, 8.35 and 9.12, 6.65 and 7.61, 7.02 and 7.62, 8.53 and 9.08 g, 0.317 and 0.414 g, 4.77 and 521.85kg, 38.99 and 39.11% in addition to 186.00 and 204.20 kg/fad. for the same characters arrangement previously mentioned.

T3

T3

On the other hand, the flax variety Belinka had the lowest estimates in all seed characters when compared with either strain 2465/3 or Sakha 1 variety. These results are in harmony with those obtained by Momtaz *et al* (1989), Mostafa *et al* (1998), l-Shimy and Moawed (2000) and Zedan (2004).

2-2- Effect of plant density:

Data indicated that the highest plant density (2000 seeds / m^2) significantly caused the highest estimates of seed yield / fad (581.65 and 546.13 kg) and oil yield / fad (182.77 and 207.56 kg) in both seasons, respectively. While gradual decrements had been observed with increasing plant density by means that the lowest dense caused highest mean values of fruiting zone length (12.26 and 11.31), number of fruiting branches / plant (9.93 and 10.49), number of capsules / plant (7.69 and 8.63), number of seeds (capsule (7.72 and 8.45), 1000 seed weight (8.19 and 8.77 gm), seed yield / plant (0.366 and 0.463 gm) and seed oil percentage (38.59 and 38.76) in both season, respectively. On the other hand, the significant increases in seed and oil yields / fad with the highest plant density (2000 seeds / m^2) comparing with the other two densities 15000 or 1750 seeds / m^2 could be attributed to the increase in number of plants per unit area. These results are in harmony with those obtained by Momtaz *et al* (1981), El-Kady *et al* (1995), Steveneson and Wight (1996), Mostafa *et al* (1998), Abdel-Wahed (2002) and Zadan (2004).

2-3- Effect of potassium fertilizer levels:

Results revealed that seed yield and its related characters were increased significantly with increasing potassium levels from 24 up to 72 kg K_2O / fad in both seasons. while fruiting zone length decreased significantly as potassium level increased. The averages obtained in the first season ranged from 9.25 to 13.10 cm and from 8.96 to 11.86 cm in the second one for fruiting zone length which performed by highest and lowest potassium levels, respectively. While the mean values of the another traits ranged from 7.26 to 9.58 and from 8.10 to 10.06 for number of fruiting branches, from 5.64 to 7.61 and from 6.60 to 8.42 for number of capsules / plant, from 6.44 to 7.96 and from 7.41 to 8.36 for number of seeds / capsule, from 7.14 to 8.30 and from 7.92 to 8.80 g for 1000-seed weight, from 0.282 to 0.356 g and from 0.374 to 0.468 g for seed yield / plant, from 419.54 to 485.75 kg and from 451.72 to 554.10 kg for seed yield / fad, from37.00 to 38.55% and from 37.35 to 38.59% for seed oil percentage and finally from 157.57 to 189.58 kg and from 171.02 to 215.74 kg for oil yield / fad in the two successive seasons, respectively. Similar results were obtained by Zedan *et al* (1997), Nassar and El-Taweel (2001), Hussein (2002) and El-Azzouni *et al* (2003).

3. Interaction effect:

Table (4), illustrated the interaction between flax genotypes (G) and plant density (D) which had significant effect on total length, main stem diameter, fiber length and number of fruiting branches in only the second season. Meanwhile, G x D interaction had significant effect in both seasons on fiber fineness and number of capsules / plant in addition to the significant effect on seed yield / fad and oil yield / fad in only the first season.

T4

T5

This mean that these two factors done their effect dependently. The highest mean values for total length (96.35 cm), fiber length (91.37 cm) and fiber fineness (233.97 Nm) obtained by Belinka variety combined with the highest plant density. While the maximum averages of main stem diameter (3.13 mm), number of fruiting branches (13.31) and number of capsules / plant (10.81) obtained by strain 2465/3 with the lowest plant density (1500 seeds / m^2). The seed yield / fad (619.33 kg) and oil yield / fad (245.49kg) obtained by strain 2465/3 combined with the highest plant density (2000 seeds/ m^2).

Table (5), results revealed that G x K (potassium levels) interaction had significant effect on total length, technical length, main stem diameter, fiber length, fiber fineness and number of fruiting branches in only the second season. While, there was significant effect on fiber percentage and oil yield / fad in only the first season. It must be mentioned here, that the maximum mean values of total length (95.75 cm), technical length (90.58 cm), fiber length (91.39 cm), fiber percentage (21.02%) and fiber fineness (240.43 Nm) were achieved by Belinka variety combined with applying flax plant by the highest potassium level at the rate of 72 kg K_2O / fad. While, the more thickness plant (3.04 mm) obtained by strain 2465/3 combined with the highest potassium level. Moreover, the highest averages of number of fruiting branches (12.22) and oil yield / fad (251.67) obtained by strain 2465/3 as affected with added 72 kg K_2O / fad.

The interaction between plant density (D) and potassium levels (K) had significant effect on total length and technical length in only the second season as shown in Table (6). The tallest averages of total length (90.72 cm) and technical length (82.85 cm) obtained by the highest plant density (2000 seeds /m^2) combined with applying the highest potassium level at the rate of 72 kg K_2O / fad.

Table (6). Interaction effect between plant density (D) and potassium levels (K) for some characters during 2004/05, 2005/06 seasons.

Characters		Total length / plant (cm)		Technical length/pl. (cm)	
Seasons / Interactions		1st	2 nd	1st	2 nd
D1	K1	Ns	78.62	Ns	65.71
	K2	NS	82.21	NS	70.71
	K3	NS	84.26	NS	74.48
Mean		Ns	81.70	Ns	70.30
D2	K1	Ns	80.86	Ns	68.96
	K2	NS	87.11	NS	76.73
	K3	NS	89.85	NS	80.57
Mean		Ns	85.94	Ns	75.42
D3	K1	Ns	82.58	Ns	71.69
	K2	NS	88.97	NS	79.17
	K3	NS	90.72	NS	82.85
Mean		Ns	87.42	Ns	77.90
L.S.D.0.05		Ns	1.65	Ns	1.46

D1= 1500seeds/m^2 D2= 1750seeds//m^2 D3= 2000 seeds//m^2
K1= 24 kg K_2O/fad K2= 48 kg K_2O/fad K3= 72 kg K_2O/fad

T7

Correlation studies:

Data presented in Table (7) showed that straw yield / fad was positively and significantly correlated with each of straw yield / plant, fiber yield / fad, fiber length, seed yield / fad, oil yield / fad and 1000- seed weight with r values of 0.569, 0.778, 0.435, 0.515, 0.488 and 0.536, respectively.

The associations between straw yield / plant and each of main stem diameter, fiber yield / fad, seed yield l plant, oil yield l fad, 1000-seed weight and number of capsules / plant were significant and positive. The r values between main stem diameter and each of seed yield / plant, seed yield / fad, oil yield / fad, 1000-seed weight and number of capsules / plant were highly significant and positive.

Fiber yield / fad was positively and significantly correlated with technical length fiber length and fiber fineness with the r values of 0.803, 0.883 and 0.822, respectively. The relationship between technical length / plant and either fiber length or fiber fineness showed highly significant and positive. The fiber length character was positive and significantly correlated with only fiber fineness, but negative r values with each of seed yield / plant as well as per fad, oil yield / fad, 1000-seed weight and number of capsules / plant. The correlation coefficient between seed yield / plant and each of seed yield / fad, oil yield / fad, 1000-seed weight and number of capsules / plant were significant and positive, also between seed yield / fad and each of oil yield / fad, 1000- seed weight and number of capsules / plant, in addition to the relation between oil yield / fad and 1000-seed weight or number of capsules / plant were highly significant and positive. These results are in accordance with those obtained by Momtaz *et al* (1977), El-Kaddoussi and Moawed (2001) and Hussein (2002).

In general, it could be stated that planting the Belinka genotype for fiber production or promising strain 2465/3 for seed yield and cold be recommend using the highest plant density *i.e.* 2000 seeds/m^2 under fertilizing with 75 kg K_2O at sandy soil condition in Ismilia region.

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تأثير الكثافة النباتية و السماد البوتاسي على المحصول وجودته لبعض التراكيب الوراثية للكتان تحت ظروف الأراضي الرملية

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قسم بحوث محاصيل الألياف - معهد بحوث المحاصيل الحقلية – مركز البحوث الزراعية

أقيمت تجربتان بمزرعة محطة البحوث الزراعية بالإسماعيلية – بمحافظة الإسماعيلية خلال الموسمين المتعاقبين ٢٠٠٤/٢٠٠٥ ، ٢٠٠٥/٢٠٠٦ وذلك لدراسة تأثير ثلاثة كثافات نباتية هم ١٥٠٠، ١٧٥٠، ٢٠٠٠ بذرة / م٢ وكذلك ثلاثة مستويات من السماد البوتاسي بمعدل ٢٤ ، ٤٨، ٧٢ كجم بو٢أ /فدان على المحصول وجودته لثلاثة تراكيب وراثية من الكتان هم بلنكا ، سخا١ ، السلالة ٣/٢٤٦٥ وذلك بالنسبة لمحصولي القش والبذرة ومكوناتهما بالإضافة إلي الارتباط بينهما – وكان التصميم الإحصائي المستخدم هو القطع المنشقة مرتين ذات الأربع مكررات.

فيما يلي ملخص للنتائج المتحصل عليها :

1- تفوق الصنف بلنكا وحقق أعلى قيم للطول الكلي ، الطول الفعال ، محصول الألياف/فدان ، طول الألياف ، النسبة المئوية للألياف وكذلك نعومة الألياف . بينما أعطى الصنف سخا١ أعلى قيم في محصول القش/نبات كما للفدان ، المحصول البيولوجي/فدان . هذا وقد تفوقت السلالة ٣/٢٤٦٥ في صفات سمك النبات ، طول المنطقة الثمرية ، عدد الفروع الثمرية ، عدد الكبسولات/ نبات ، عدد البذور في الكبسولة ، وزن الألف بذرة ، محصول البذور/نبات وللفدان ، النسبة المئوية للزيت ، ومحصول الزيت/فدان.

2- زيادة معدل الكثافة النباتية من ١٥٠٠ إلى ٢٠٠٠ بذرة/م٢ أدى إلى زيادة معظم الصفات تحت الدراسة لمحصولي القش، البذور فيما عدا صفات سمك الساق ، محصول القش /نبات ، طول المنطقة الثمرية ، عدد الفروع الثمرية ، عد الكبسولات/نبات ، عدد البذور في الكبسولة ، محصول البذور/نبات ، النسبة المئوية للزيت حيث حدث نقص في متوسطات هذه الصفات بزيادة الكثافة النباتية .

3- أدى زيادة معدل السماد البوتاسي إلى زيادة في كل صفات القش و البذور تحت الدراسة باستثناء صفتي نعومة الألياف ، طول المنطقة الثمرية حيث حدث بهما نقص تدريجي .

4- كانت هناك معنوية عالية وموجبة في قيم الارتباط لظاهري بين صفة محصول القش/فدان وكل من محصول القش/نبات ، محصول الألياف/فدان ، طول الألياف ، محصول البذور/فدان ، محصول الزيت/فدان وكذلك وزن الألف بذرة . وكانت قيم الارتباط معنوية وموجبة أيضا بين محصول البذرة/فدان وكل من محصول الزيت/فدان ، وزن الألف بذرة ، عدد الكبسولات/نبات.

Table (2_a). Mean values of straw yield and its related characters of some flax genotypes, as affected by plant density and potassium levels In 2004/05, 2005/06 seasons.

characters	Total length / plant (cm)		Technical length / plant (cm)		Main stem diameter (mm)		Straw yield / Plant (g)		Straw yield / Fad (ton)	
Season / Treatment	1st	2 nd	1st	2 nd	1st	2 nd	1st	2 nd	1st	2 nd
Genotypes (G)										
Sakha1 (G1)	81.67b	84.25b	70.43b	74.10b	2.10b	2.35b	1.332a	1.680a	3.041a	3.073a
S. 2465/3 (G2)	74.39b	77.83c	59.89c	63.67c	2.45a	2.80a	0.979b	1.480ab	2.602	2.810a
Belinka (G3)	91.06a	92.99a	84.62a	85.86a	1.71c	1.49c	0.848b	1.301b	2.470b	2.558c
F. test	**	**	**	**	**	**	**	*	*	**
LSD 0.01	1.87	3.73	2.13	1.97	0.30	0.30	0.228	0.255	0.332	0.227
Plant density (D)										
1500 seeds/m^2 (D1)	78.78b	81.70c	67.49c	70.30c	2.48a	2.49a	1.146a	1.623a11.4	2.331b	2.522b
1750 seeds/m^2 (D2)	83.71a	85.94b	72.49b	75.42b	1.99b	2.18b	1.054ab	98ab	2.835a	2.868a
2000 seeds/m^2 (D3)	84.63a	87.43a	74.96a	77.90a	1.78b	1.97c	0.959b	1.339b	2.947a	3.051a
F. test	**	**	**	**	**	**	*	*	*	*
LSD 0.01	1.93	0.96	1.86	1.49	0.34	0.12	0.118	0.208	0.449	0.337
Potassium levels (K)										
24 kg K2O/Fad (K1)	77.79c	80.69c	65.09c	68.79c	1.93c	1.97c	0.866c	1.239c	2.199b	2.404b
48 kg K2O/fad (K2)	83.85b	86.10b	73.24b	75.54b	2.09b	2.25b	1.081b	1.546b	2.900a	2.944a
72 kg K2O/fad (K3)	85.48a	88.28a	76.61a	79.30a	2.23a	2.42a	1.211a	1.675a	3.014a	3.092a
F. test	**	**	**	**	**	**	**	**	**	**
LSD 0.01	1.03	0.95	1.24	0.84	0.05	0.06	0.095	0.106	0.184	0.221
interaction										
G x D	Ns	*	Ns	Ns	Ns	*	Ns	Ns	Ns	Ns
G x K	NS	*	NS	*	NS	*	NS	NS	NS	NS
D x K	NS	*	NS	*	NS	NS	NS	NS	NS	NS
G x D x K	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

***,** Indicate only significant and highly significant, respectively.**

Table (2_b). Mean values of biological yield/fad, fiber yield/fad, fiber length, fiber percentage and fiber fineness as of some flax genotypes, affected by plant density and potassium levels In 2004/05, 2005/06 seasons.

characters	Biological yield/fed (ton)		Fiber yield/fad (ton)		Fiber length (cm)		Fiber percentage (%)		Fiber fineness (Nm)	
Season / Treatment	1st	2 nd	1st	2 nd	1st	2 nd	1st	2 nd	1st	2 nd
Genotypes (G)										
Sakha1 (G1)	3.518a	3.598a	0.502a	0.524a	76.78b	80.09b	16.44b	16.46b	201.79b	206.74b
S. 2465/3 (G2)	3.192a	3.449a	0.383b	0.410b	71.32c	71.71c	14.18c	14.51c	190.26c	199.20c
Belinka (G3)	2.779b	2.946b	0.509a	0.525a	86.19a	87.99a	20.28a	20.40a	220.60a	230.11a
F. test	**	**	**	**	**	**	**	**	**	**
LSD 0.01	0.328	0.219	0.065	0.043	2.04	2.17	0.43	0.32	5.07	3.57
Plant density (D)										
1500 seeds/m^2 (D1)	2.755b	2.997b	0.394ab	0.422b	72.82b	76.26c	16.42b	16.81c	195.57c	201.32c
1750 seeds/m^2 (D2)	3.305a	3.396a	0.485a	0.497a	80.22a	80.98b	17.17a	17.38b	204.93b	215.58b
2000 seeds/m^2 (D3)	3.429a	3.600a	0.515a	0.538a	81.25a	82.55a	17.30a	17.70a	211.65a	219.15a
F. test	*	**	*	**	**	**	*	**	**	**
LSD 0.01	0.447	0.334	0.095	0.068	1.32	1.13	0.65	0.29	2.32	2.83
Potassium levels (K)										
24 kg K2O/Fad (K1)	2.617b	2.856c	0.362b	0.398c	72.82c	72.18b	16.25b	16.52c	209.22a	220.34a
48 kg K2O/fad (K2)	3.371a	3.487b	0.503a	0.510b	79.76b	82.78a	17.20a	17.46b	206.85b	219.14a
72 kg K2O/fad (K3)	3.500a	3.650a	0.528a	0.549a	81.70a	84.85a	17.45a	17.90a	196.08c	196.57b
F. test	**	**	**	**	**	**	**	**	**	**
LSD 0.01	0.184	0.145	0.053	0.024	1.08	0.71	0.33	0.21	2.04	1.75
interaction										
G x D	Ns	Ns	Ns	Ns	Ns	*	Ns	Ns	**	**
G x K	NS	NS	NS	NS	NS	*	*	NS	NS	*
D x K	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
G x D x K	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

***,** Indicate only significant and highly significant, respectively.**

Table (3_a). Mean values of fruiting zone length, fruiting branches, No. of capsules/plant ,1000-seed weight and No. of seeds/capsule of some flax genotypes, as affected by plant density and potassium levels In 2004/05, 2005/06 seasons.

characters	Fruiting zone length /plant (cm)		Number of fruiting Branches/plant		Number of seeds/ capsule		Number of capsules/plant		1000-seed weight (g)	
Season / Treatment	1st	2 nd	1st	2 nd	1st	2 nd	1st	2 nd	1st	2 nd
Genotypes (G)										
Sakha1 (G1)	11.13b	10.10b	8.35b	9.12b	7.02b	7.62b	6.65b	7.61b	8.53a	9.08b
S. 2465/3 (G2)	14.61a	14.08a	10.44a	11.21a	8.26a	8.89a	7.94a	9.23a	9.33a	10.09a
Belinka (G3)	7.70 c	7.13c	6.85c	7.38c	6.76c	7.42b	5.54c	6.14c	5.62b	5.98c
F. test	**	**	**	**	*	**	**	**	**	**
LSD 0.01	1.17	2.69	0.13	0.59	0.83	0.32	0.39	0.69	0.93	0.34
Plant density (D)										
1500 seeds/m^2 (D1)	12.26a	11.31a	9.93a	10.49a	7.72a	8.45a	7.69a	8.63a	8.19 a	8.77 a
1750 seeds/m^2 (D2)	11.33b	10.52ab	8.25b	9.07 b	7.33ab	7.89b	6.43b	7.59b	7.88 b	8.47 a
2000 seeds/m^2 (D3)	9.86 c	9.49 b	7.45b	8.15 c	7.00b	7.58b	6.06b	6.76c	7.40 c	7.92 b
F. test	**	*	**	**	**	**	**	**	**	**
LSD 0.01	0.75	1.45	0.59	0.32	0.42	0.39	0.54	0.32	0.19	0.34
Potassium levels (K)										
24 kg K2O/Fad (K1)	13.10a	11.86a	7.26c	8.10c	6.44c	7.41c	5.64c	6.60c	7.14c	7.92c
48 kg K2O/fad (K2)	11.09b	10.47b	8.80b	9.55b	7.64b	8.16b	6.92b	7.96b	8.04b	8.44b
72 kg K2O/fad (K3)	9.25c	8.98c	9.58a	10.06a	7.96a	8.36a	7.61a	8.42a	8.30a	8.80a
F. test	**	**	**	**	**	**	**	**	**	**
LSD 0.01	0.73	1.08	0.24	0.16	0.21	0.12	0.25	0.27	0.16	0.16
interaction										
G x D	Ns	Ns	Ns	*	Ns	Ns	Ns	Ns	*	**
G x K	NS	NS	NS	*	NS	NS	NS	NS	NS	NS
D x K	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
G x D x K	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

***,** Indicate only significant and highly significant, respectively.**

Table (3b). Mean values of seed yield / plant, seed yield / fad, oil percentage and oil yield / fad of some flax genotypes, as affected by plant density and potassium levels In 2004/05, 2005/06 seasons.

characters	Seed yield/plant (g)		Seed yield/fad (kg)		Oil percentage (%)		Oil yield/fad (kg)	
Season / Treatment	1st	2 nd	1st	2 nd	1st	2 nd	1st	2 nd
Genotypes (G)								
Sakha1 (G1)	0.317b	0.414b	477.41b	521.85b	38.99	39.11	186.00b	204.20b
S. 2465/3 (G2)	0.410a	0.506a	589.57a	639.41	40.01	40.16	235.79a	256.73a
Belinka (G3)	0.250c	0.345c	310.07c	389.61	34.74	34.99	107.90c	135.90c
F. test	**	**	**	*	**	**	**	**
LSD 0.01	0.050	0.068	22.30	17.48	0.28	0.35	8.14	5.80
Plant density (D)								
1500 seeds/m^2 (D1)	0.366a	0.463a	425.44b	474.65b	38.59a	38.76a	166.51b	186.22b
1750 seeds/m^2 (D2)	0.322ab	0.413ab	469.95a	528.09a	37.78b	37.98b	180.40a	203.05a
2000 seeds/m^2 (D3)	0.289b	0.389b	481.65a	546.13a	37.37c	37.53c	182.77a	207.56a
F. test	**	*	**	**	**	**	**	*
LSD 0.01	0.045	0.049	10.11	34.88	0.40	3.75	3.75	13.58
Potassium levels (K)								
24 kg K2O/Fad (K1)	0.282c	0.374c	419.54c	451.72b	37.00c	37.35c	157.57c	171.02b
48 kg K2O/fad (K2)	0.339b	0.422b	471.75b	543.05a	38.19b	38.33b	182.53b	210.07a
72 kg K2O/fad (K3)	0.356a	0.468a	485.75a	554.10a	38.55a	38.59a	189.58a	215.74a
F. test	**	**	**	**	**	**	**	**
LSD 0.01	0.021	0.028	8.25	19.53	0.25	0.22	3.02	7.71
interaction								
G x D	Ns	Ns	*	Ns	Ns	Ns	*	Ns
G x K	NS	NS	NS	NS	NS	NS	*	NS
D x K	NS	NS	NS	NS	NS	NS	NS	NS
G x D x K	NS	NS	NS	NS	NS	NS	NS	NS

***,** Indicate only significant and highly significant, respectively.**

Table (4). Interaction effect between flax genotypes (G) and plant density (D) for some characters during 2004/05, 2005/06 seasons.

Characters		Total length / plant (cm)		Mean stem diameter (mm)		Fiber length (cm)		Fiber fineness (Nm)		No. of fruiting branches/ plant		No. of capsules/ plant		Seed yield/ Fad (kg)		Oil yield/fad (kg)	
Seasons / Interactions		1st	2 nd	1st	2 nd	1st	2 nd	1st	2 nd	1st	2 nd	1st	2 nd	1st	2 nd	1st	2 nd
G1	D1	Ns	82.24	Ns	**2.78**	Ns	77.77	187.42	192.54	Ns	10.15	7.29	8.38	447.90	Ns	175.36	Ns
	D2	NS	84.41	NS	2.26	NS	80.68	203.09	213.21	NS	9.09	6.38	7.65	483.96	NS	188.02	NS
	D3	NS	86.09	NS	2.02	NS	81.83	213.36	214.46	NS	8.12	6.28	6.80	505.37	NS	194.61	NS
Mean		Ns	84.25	Ns	2.35	Ns	80.09	201.29	206.74	Ns	9.12	6.65	7.61	447.41	Ns	185.94	Ns
G2	D1	Ns	74.99	Ns	3.13	Ns	68.09	184.46	186.78	Ns	13.31	9.81	10.81	535.50	Ns	219.04	Ns
	D2	NS	78.65	NS	2.81	NS	72.59	190.40	201.81	NS	10.64	7.51	9.00	613.88	NS	244.84	NS
	D3	NS	79.84	NS	2.46	NS	74.45	195.91	209.01	NS	9.61	6.64	7.89	619.33	NS	245.49	NS
Mean		Ns	77.83	Ns	2.80	Ns	71.71	190.26	199.20	Ns	11.20	7.99	9.23	589.57	Ns	235.79	Ns
G3	D1	Ns	87.86	Ns	1.57	Ns	82.94	214.83	224.63	Ns	8.01	5.98	6.71	297.93	Ns	105.15	Ns
	D2	NS	94.76	NS	1.47	NS	89.65	221.30	231.71	NS	7.43	5.40	6.12	312.02	NS	108.34	NS
	D3	NS	96.35	NS	1.43	NS	91.37	225.68	233.97	NS	6.71	5.24	5.60	320.24	NS	110.21	NS
Mean		Ns	92.99	Ns	1.49	Ns	89.99	220.60	230.10	Ns	7.38	5.54	6.14	310.06	Ns	107.90	Ns
L.S.D.		Ns	1.66	Ns	0.20	Ns	1.95	4.02	4.90	Ns	1.02	0.94	0.55	17.52	Ns	6.50	Ns

G1= Sakha1 G2= S.2465/3 G3= Belinka
D1= 1500seeds/m^2 D2= 1750seeds//m^2 D3= 2000 seeds//m^2

Table (5). Interaction effect between flax genotypes (G) and potassium levels (K) for some characters during 2004/05, 2005/06 seasons.

characters		Total length / plant (cm)		Technical length/pl. (cm)		Main stem diameter (mm)		Fiber length (cm)		Fiber percentage (%)		Fiber fineness (Nm)		No. of fruiting branches/ plant		Oil yield/fad (kg)	
Seasons / Interactions		1st	2 nd	1st	2 nd	1st	2 nd	1st	2 nd	1st	2 nd	1st	2 nd	1st	2 nd	1st	2 nd
G1	K1	Ns	80.72	Ns	69.48	Ns	2.08	Ns	73.19	15.99	Ns	Ns	195.04	Ns	8.07	169.73	Ns
	K2	NS	85.33	NS	74.89	NS	2.42	NS	82.77	16.60	NS	NS	212.07	NS	9.45	191.05	NS
	K3	NS	86.68	NS	77.92	NS	2.56	NS	84.32	16.73	NS	NS	213.10	NS	9.83	197.21	NS
Mean		Ns	84.24	Ns	74.10	Ns	2.35	Ns	80.09	16.44	Ns	Ns	206.74	Ns	9.12	185.99	Ns
G2	K1	Ns	72.05	Ns	57.02	Ns	2.48	Ns	61.66	13.62	Ns	Ns	184.40	Ns	9.81	211.79	Ns
	K2	NS	79.02	NS	64.59	NS	2.88	NS	74.69	14.32	NS	NS	205.72	NS	11.58	243.91	NS
	K3	NS	82.41	NS	69.40	NS	3.04	NS	78.79	14.58	NS	NS	207.49	NS	12.22	251.67	NS
Mean		Ns	77.83	Ns	63.67	Ns	2.80	Ns	71.71	14.17	Ns	Ns	199.20	Ns	11.20	235.79	Ns
G3	K1	Ns	89.28	Ns	79.86	Ns	1.35	Ns	81.69	19.12	Ns	Ns	210.27	Ns	6.42	91.18	Ns
	K2	NS	93.94	NS	87.14	NS	1.45	NS	90.88	20.69	NS	NS	239.62	NS	7.60	112.64	NS
	K3	NS	95.75	NS	90.58	NS	1.66	NS	91.39	21.02	NS	NS	240.43	NS	8.13	119.87	NS
Mean		Ns	92.99	Ns	85.86	Ns	1.49	Ns	87.99	20.28	Ns	Ns	230.11	Ns	7.38	107.90	Ns
L.S.D. 0.05		Ns	1.65	Ns	1.46	Ns	0.08	Ns	1.24	0.56	Ns	Ns	3.03	Ns	0.29	5.23	Ns

G1= Sakha1 G2= S.2465/3 G3= Belinka
K1= 24 kg K_2O/fad K2= 48 kg K_2O/fad K3= 72 kg K_2O/fad

Table (7). Simple correlation coefficient among straw and seed yields as well as other related characters from the combined data over the two experimental seasons (2004/05 and 2005/06).

Characters		2	3	4	5	6	7	8	9	10	11	12
1	Straw yield / fad (ton)	0.569**	0.133	0.778**	0.262	0.435*	0.349	0.179	0.515**	0.488**	0.536**	0.206
2	Straw yield / plant (g)	-	0.601**	0.414*	-0.088	0.348	-0.155	0.516**	0.372	0.414*	0.466*	0.578**
3	Main Stem diameter		-	-0.380	-0.686**	-0.590**	-0.692**	0.920**	0.688**	0.745**	0.728**	0.932**
4	Fiber yield / fad (kg)			-	0.803**	0.883**	0.822**	-0.296	-0.088	-0.131	-0.082	-0.221
5	Technical length (cm)				-	0.969**	0.943**	-0.611**	-0.600**	-0.640**	-0.640**	-0.523**
6	Fiber length (cm)					-	0.960**	-0.505**	-0.132	-0.460*	-0.475*	-0.405*
7	Fiber fineness (Nm)						-	-0.519**	-0.426*	-0.480*	-0.516**	-0.466*
8	Seed yield/plant (g)							-	0.751**	0.794**	0.736**	0.976**
9	Seed yield / fad (Kg)								-	0.996**	0.960**	0.668**
10	Oil yield / fad (kg)									-	0.968**	0.719**
11	1000-seed weight (g)										-	0.675**
12	No. of capsules/plant											-

***,** Indicate significant and highly significant, respectively.**