

RESPONSE OF SOME FLAX GENOTYPES TO COMBINATIONS OF NPK FERTILIZER

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ABSTRACT

Two field experiments were carried out at Gemmiza Res. Station, Gharbia Governorate, Agric. Res. Center during the two successive seasons of 2004/05 and 2005/06 to study the response of six flax genotypes namely Sakha 1, Sakha 2, 402/2/5/10, 420/140, 329/2/18 and S.336/2/1/2 to the three NPK fertilizers i.e., 0 control, (45 kg N + 15 kg P₂O₅ + 24 kg K₂O / fed) and (60 kg N + 30 kg P₂O₅ + 24 kg K₂O / fed). Split plot design with four replications was used.

The results of this investigation could be summarized as follow:

- 1- The flax variety Sakha 1 recorded maximum mean values and surpass the other genotypes concerning straw yield / fed as well as per plant, plant height, technical length and fiber yield / fed, while S.336/2/1/2 recorded lowest estimates for most economic straw traits.
- 2- The flax variety Sakha 2 ranked first and superior the remain genotypes regarding all studied seed characters i.e., seed yield / fed as well as per plant, no. of capsules / plant, no. of seeds / capsule, no. of seeds / plant and no. of apical branches.
- 3- Application of NPK fertilizer caused gradual increment in all straw and seed yields in addition to their components with increasing NPK level from 0 control towards the highest level.
- 4- The interaction between genotypes and NPK levels had significant effect on straw yield / fed, fiber yield / fed, seed yield / fed, no. of capsules / plant and no. of seeds / capsule.
- 5- The correlation coefficients between plant height and each of technical length and straw yield / plant were highly significant and positive, the r value between technical length and straw yield / plant was only significant and positive. The relationships between no. of apical branches and each of no. of capsules / plant, stem diameter and straw yield / plant were positive and highly significant, but it was positive and only significant with no. of seeds / plant. The r values between no. of capsules / plant and each of stem diameter, straw yield / plant, seed yield / plant, no. of seeds / plant and fruiting zone length were highly significant and positive.

In general, it could be summarized that the flax variety Sakha 1 cultivated for high straw and fiber yields. While Sakha 2 for seed and oil yields, it must apply 45 kg N + 15 kg P₂O₅ + 24 kg K₂O / fed to the two flax varieties for obtaining highest yield. The breeder must take care plant height for high straw and fiber yields in addition to no. of capsules / plant for seed yield.

INTRODUCTION

Flax (*Linum usitatissimum* L.) belongs the bast fiber crops group and ranked first among them in Egypt. It is traditional source of fiber and oil as a main products since several years ago. The flax cultivating area in recent time did not enough to cover the great demands especially from linseed oil. For this reason, the main objective of this study is to determine the optimum level of nitrogen, phosphorus and potassium as a mixture (NPK), which cause maximum yield quantity from some flax genotypes. Many investigators found differences among genotypes in relation to straw and seed yields such

as Momtaz *et al.*, (1990), El-Shimy and Moawed (2000), El-Azzouni (2003), Nashy (2005) and Abo-Kaied *et al.*, (2006). Many workers reported the importance of applying the three elements *i.e.*, N, P and K as a fertilizer for increasing flax plants growth, consequently straw, fiber and seed production, from these researchers Hella *et al.*, (1988), Nassar and El-Toweel (2001) and El-Shimy *et al.*, (2002). Moreover, the correlation coefficients among some flax characters to determine the more effect traits on each flax yield as a guidance for selection in plant breeding program. In this case, some investigators calculated the *r* values in flax as Mishra and Singh (1992), El-Shimy *et al.*, (1998), Zahana (2004) and Abo-Kaied *et al.*, (2006).

MATERIALS AND METHODS

Two field experiments were carried out at Gemmiza Agric. Res. Station, Agric. Res. Center, Gharbia Governorate, Egypt, during the two successive seasons 2004/05 and 2005/06 to study yield, and yield components of six flax genotypes as affected by NPK levels. The soil type was clay loam with organic matter of 2.18 and 2.23 %, available nitrogen 23.85 and 26.77 ppm, CaCO₃ of 1.51 and 1.68% and pH value of 8.01 and 8.11 in the first and second seasons, respectively. A split-plot design with four replications was used. Flax genotypes Sakha 1, Sakha 2, S.402/2/5/10, 420/140, S.329/2/18 and S.336/1/2/1 were assigned in the main plots and NPK levels *i.e.*, 0 control, 45 kg N + 15 kg P₂O₅ + 24 kg K₂O / fed and 60 kg N + 30 kg P₂O₅ + 24 kg K₂O / fed as sub-plot. In both seasons the sub-plot size was 2x3 meters (6m²) which represent 1/700 fed. The NPK fertilizer was added at two equal dose, the first dose was applied at sowing and the last dose was applied after 45 days from sowing. Flax was sown on November 17 and 20 in the first and second seasons, respectively. Flax seeds were drilled in rows 20 cm apart at rate of 60 kg N / fed. Other cultural practices were followed as usual.

At full maturity ten guarded plants were taken at random from each plot to be used for recording yield components. Flax straw, fiber and seed yield / fed were calculated from the sub-plot area bass the following data were recorded:

Yield and yield components:

A-Straw yield and its related characters:

Straw yield / fed (ton), straw yield / plant (g), plant height (cm), technical length (cm), stem diameter (mm), fruiting zone length (cm) and fiber yield / fed.

B- Seed yield and its related characters:

Seed yield/fed (kg), seed yield / plant (g), number of capsules / plant, number of seeds / capsule, number of seeds / plant and number of apical branches.

Statistical analysis: Analysis of variance was computed according to Snedecor and Cochran (1982) and means were compared by least significant differences (LSD) at 5% level. Homogeneity test (Bartlett, test) was performed for error terms of each season before using combined analysis. combined analysis was performed for all characters over two seasons (Le Clerg *et al.*, 1966).

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

$r_{xy} = \frac{Sp_{xy}}{(SS_x \cdot SS_y)^{0.5}}$ where: Sp_{xy} is the phenotypic covariance between two traits, SS_x phenotypic standard deviation of the first trait and SS_y phenotypic standard deviation of the second trait.

RESULTS AND DISCUSSION

Yield and yield components:

A- Straw yield and its related characters:

Mean values of straw yield and its related characters for flax genotypes as affected by NPK fertilizer levels from the combined analysis over two successive seasons are presented in Table 1.

Analysis of variance indicated significant differences between the six flax genotypes and also between the three NPK levels concerning straw yield / fed as well as per plant, plant height, technical length, stem diameter, fruiting zone length and fiber yield / fed except with fruiting zone length did not reach the level of significance as affected by NPK. The flax variety Sakha 1 ranked first and surpass the other five genotypes in straw yield / fed, straw yield / plant, plant height, technical length and fiber yield / fed with the average of 4.44 ton / fed, 1.730 g /plant, 102.82 cm, 87.01 cm and 662.85 kg / fed, respectively. Meanwhile, Sakha 2 achieved tallest fruiting zone length (17.55 cm) and S.402/3/5/10 reached maximum plant thickness (2.47 mm). On the other hand, the flax strain S.336/2/1/2 recorded the lowest estimates regarding straw yield / fed (3.88 ton / fed), plant height (95.7 cm), technical length (80.3 cm) and fiber yield / fed (508.62 kg). In addition to this flax strain ranked fifth in relation to straw yield / plant (1.5 g). the superiority percentages between the maximum estimates and the lowest one which obtained by flax genotypes were 14.43, 18.09, 7.44, 8.34, 6.45, 15.38 and 30.32% for straw yield / fed, straw yield / plant, plant height, technical length, stem diameter, fruiting zone length and fiber yield / fed. It must be mentioned that the differences between flax genotypes regarding the studied characters were mainly due to the genetical make up for each one and are agreement with those obtained by Momtaz *et al.*, (1990), El-Shimy and Moawed (2000), El-Azzouni *et al.*, (2003), Nashy (2005) and Abb-Kaied *et al.*, (2006).

With respect to NPK fertilizer effect, data revealed that there was gradual increment in all the seven straw yield characters when NPK increased from the untreated control (0) up to add the highest level of 60 kg N + 30 kg P₂O₅ + 24 kg K₂O / fed. The straw yield / fed ranged from 3.38 to 4.38 ton, straw yield / plant ranged from 1.41 to 1.75 gm, plant height ranged from 96.3 to 101.2 cm, technical length ranged from 80.9 to 84.7 cm, stem diameter ranged from 2.3 to 2.5 mm, fruiting zone length ranged from 15.4 to 16.5 cm and fiber yield / fed ranged from 492.51 to 629.16 kg for the control and highest NPK level, respectively. The respective superiority ratios between the maximum NPK level and the control in the same characters arrangement which previously mentioned were 29.59, 24.22, 5.02, 4.63, 9.29, 7.07 and 27.75%, respectively. It must be observed that the differences in all the seven straw characters under study as resulted from applied the second NPK level (45 kg N + 15 kg P₂O₅ + 24 kg K₂O / fed) and the highest one (third NPK level) which mentioned before did not reach the level of significance.

Similar findings were reported by Hella *et al.*, (1988), Nassar and El-Toweel (2001) and El-Shimy *et al.*, (2002).

Table 1. Mean values of straw yield and its related characters for flax genotypes as affected by NPK levels(combined analysis of the two seasons).

Genotypes	NPK	Straw yield/fed. (ton)	Straw yield/plant(gm)	Plant height (cm)	Technical Length (cm)	Stem diameter (mm)	Fruiting zone length(cm)	Fiber yield / fed (kg)
Sakha 1	1	3.800	1.550	100.2	85.6	2.3	14.7	609.10
	2	4.770	1.746	103.7	86.6	2.4	17.1	687.00
	3	4.760	1.894	104.5	88.9	2.4	15.7	692.44
	Means	4.443	1.730	102.8	87.0	2.4	15.8	662.85
Sakha 2	1	3.590	1.519	98.0	79.8	2.3	18.1	511.05
	2	4.500	1.732	98.7	82.7	2.4	15.9	634.50
	3	4.520	1.873	101.7	83.1	2.5	18.6	639.22
	Means	4.203	1.708	99.4	81.9	2.4	17.6	594.92
S.402/3/5	1	3.160	1.505	96.1	81.7	2.3	14.5	468.31
	2	4.110	1.696	96.3	81.8	2.5	14.5	610.39
	3	4.220	1.709	99.1	82.4	2.5	16.7	619.86
	Means	3.830	1.637	97.2	82.0	2.5	15.2	566.19
S.420/140	1	3.628	1.295	95.7	80.7	2.2	15.0	519.50
	2	4.601	1.465	98.0	81.8	2.4	16.1	662.56
	3	4.635	1.680	102.2	84.6	2.5	17.6	674.20
	Means	4.288	1.480	98.6	82.4	2.3	16.2	618.75
S.329/2/18	1	2.982	1.260	95.2	79.6	2.2	15.6	444.62
	2	3.826	1.474	95.8	80.3	2.4	15.5	572.59
	3	3.873	1.662	99.6	85.1	2.5	14.5	580.50
	Means	3.560	1.465	96.9	81.7	2.4	15.2	532.57
S.336/2/1/2	1	3.120	1.340	92.8	78.1	2.3	14.7	402.48
	2	4.250	1.395	94.5	78.9	2.3	15.6	554.63
	3	4.270	1.703	99.8	83.9	2.4	15.9	568.76
	Means	3.880	1.479	95.7	80.3	2.3	15.4	508.62
Mean for NPK levels								
1		3.380	1.412	96.3	80.9	2.3	15.4	492.51
2		4.343	1.585	97.8	82.0	2.4	15.8	620.28
3		4.380	1.754	101.2	84.7	2.5	16.5	629.16

L.S.D. 0.05 level of significance for:

Genotypes (G)	0.045	0.240	3.8	3.8	0.1	1.1	18.50
NBK	0.970	0.260	3.6	3.3	0.2	ns	15.42
G x NBK	0.167	ns	ns	ns	ns	ns	10.64

ns = non-significant.

1= (NPK= Zero)

2= (N=45, P=15 and K=24Kg/fed)

3=(N=60, P=30 and K=24Kg/fed)

The interaction between genotypes and NPK level had significant effect on straw yield and fiber yield / fed, by means that these two factors under this study done their effect dependently in this case. The maximum estimates for straw yield / fed (4.76 or 4.77 ton / fed), straw yield / plant (1.894 g), plant height (104.5 cm), technical length (88.9 cm) and fiber yield / fed (692.44 kg) were obtained by Sakha 1 combined with the highest NPK level, except with the first trait which second and third NPK levels sharing in this case without significant difference. While Sakha 2 achieved tallest fruiting zone length (18.6 cm) combined with the highest NPK level, in addition to more thickness plant obtained by S.402/3/510 combined with the second NPK level (2.6 mm) or by the third one (2.5 mm).

B- Seed yield and its related characters:

The results in Table 2, the statistical analysis either the flax genotypes or NPK levels were differed significantly among the combined analysis for all the six seed characters under study.

The flax variety Sakha 2 achieved maximum estimates for seed yield / fed (673.37 kg), seed yield / plant (0.457 gm), no. of capsules / plant (7.9), no. of seeds / capsule (6.6), no. of seeds / plant (52.4) and no. of apical branches (11.3). on the other hand, the minimum estimates were obtained by S.402/3/5/10 for seed yield / fed (454.33 kg) and also for seed yield / plant (0.412 g), the flax strain S.329/2/18 for no. of capsules / plant (6.8) and also no. of seeds / plant (39.2), no. of seeds / capsule (5.7) which obtained by S.336/2/1/2 and no. of apical branches (10.0) obtained by S.420/140. The superiority percentages between the maximum and minimum estimates regarding seed characters were 48.21, 10.92, 15.23, 16.37, 33.54 and 13.67% for seed yield / fed, seed yield / plant, no. of capsules / plant, no. of seeds / capsule, no. of seeds / plant and no. of apical branches, respectively. These results are in harmony with those obtained by Momtaz *et al.*, (1990), El-Deeb (1998), El-Azzouni *et al.*, (2003), Nashy (2005) and Abo-Kaied *et al.*, (2006).

Concerning NPK fertilizer effect, results indicated that all seed characters gradually increased with increasing NPK level from control treatment towards the highest NPK level. The mean values of seed yield / fed. ranged from 430.35 to 686.11 kg, seed yield / plant ranged from 0.400 to 0.486 g, no. of capsules/ plant ranged from 6.2 to 8.3, no. of seeds/ capsule ranged from 5.5 to 6.2, no. of seeds / plant ranged from 34.3 to 51.9 and no. of apical branches ranged from 9.4 to 11.9 / plant. The superiority percentages between the highest and lowest estimates for the six seed traits previously mentioned were 59.43, 21.50, 34.52, 11.91, 51.14 and 27.05%, respectively. The differences between the averages of seed characters as affected by applying the second (intermediate) or the highest NPK level (the third) did not reach the level of significance except with seed yield / fed character. These results are in agreement with those obtained by Hella *et al.*, (1988), Nasser and El-Taweel (2001) and El-Shimy *et al.*, (2002).

Table 2. Mean values of seed yield and its related characters for flax genotypes as affected by NPK levels (combined analysis of the two seasons).

Genotypes	NPK	Seed yield/fed.(kg)	Seed yield/plant(gm)	No.of capsules/plant	No.of seeds/capsules	No.of seeds/plant	No.of optical branches
Sakha 1	1	554.45	0.427	6.5	5.6	36.4	10.2
	2	669.68	0.441	6.9	5.9	40.6	11.1
	3	722.30	0.477	8.1	6.0	48.0	11.8
	Means	648.81	0.448	7.2	5.8	41.7	11.0
Sakha 2	1	532.15	0.376	6.4	6.1	38.9	9.3
	2	724.65	0.444	8.1	6.8	55.1	10.9
	3	763.30	0.550	9.1	7.0	63.2	13.7
	Means	673.37	0.457	7.9	6.6	52.4	11.3
S.402/3/5	1	308.85	0.393	6.2	5.6	34.4	9.5
	2	495.15	0.402	7.4	6.5	48.4	11.0
	3	558.98	0.440	8.6	6.2	53.6	12.7
	Means	454.33	0.412	7.4	6.1	45.4	11.0
S.420/140	1	349.93	0.433	5.8	5.4	31.2	8.8
	2	707.35	0.441	7.1	6.3	44.8	9.9
	3	724.05	0.444	8.4	6.3	53.0	11.2
	Means	593.78	0.439	7.1	6.0	43.0	9.9
S.329/2/18	1	416.20	0.398	5.8	5.5	31.6	9.7
	2	679.25	0.430	7.1	6.0	42.6	10.2
	3	696.38	0.496	7.6	5.7	43.6	10.7
	Means	597.28	0.441	6.8	5.7	39.2	10.2
S.336/2/1/2	1	420.55	0.374	6.5	5.2	33.5	8.9
	2	567.43	0.393	7.8	5.8	45.3	11.5
	3	651.68	0.506	8.3	6.0	49.9	11.5
	Means	546.55	0.424	7.5	5.7	42.9	10.7
Mean for NPK levels							
1		430.35	0.400	6.2	5.5	34.3	9.4
2		640.59	0.425	7.4	6.2	46.1	10.8
3		686.11	0.486	8.3	6.2	51.9	11.9

L.S.D. 0.05 level of significance for:

Genotypes (G) 10.47 0.040 0.9 0.5 5.2 1.1

NBK 23.36 0.067 2.0 ns 14.7 1.7

G x NBK 40.46 ns 1.6 0.7 ns ns

ns = non-significant.

1= (NPK= Zero)

2= (N=45, P=15 and K=24Kg/fed)

3=(N=60, P=30 and K=24Kg/fed)

Genotypes x NPK levels interaction had significant effect on seed yield / fed, no. of capsules / plant and no. of seeds / capsule. The maximum estimates for seed yield / fed (763.30kg), seed yield / plant (0.550g), no. of capsules / plant (9.1), no. of seeds / capsule (7.0), no. of seeds / plant (63.2) and no. of apical branches (13.7) were obtained by the flax variety Sakha 2 combined with the highest NPK level.

Generally, the flax variety Sakha 1 recorded the maximum mean values of the most economic straw characters including fiber yield / fed . Meanwhile, the flax variety Sakha 2 achieved highest estimates for seed characters under study. The differences between character averages as resulted by applied intermediate NPK level and highest one did not reach the level of significance for all straw and seed traits. Therefore, it can be recommended by cultivating Sakha 1 to obtain highest straw and fiber yields, cultivating Sakha 2 for achieving maximum seed yield, in addition to add NPK fertilizer at the level of 45 kg N + 15 kg P₂O₅ + 24 kg K₂O / fed (intermediate level) for both two flax varieties (Sakha 1 and Sakha 2) under this investigation.

Correlation study:

Results in Table (3), indicated that the correlation coefficients between plant height and each of technical length (0.934) and straw yield / plant (0.646) were positive and highly significant, but it was only significant and negative with seed yield / plant (-0.583). The r value between technical length and straw yield / plant (0.504) was only significant positive while it was highly significant and negative with seed yield / plant. The relationships between number of apical branches and each of no. of capsules / plant (0.735), stem diameter (0.781) and straw yield / plant (0.899) were highly significant positive, while appeared to be only significant positive with no. of seeds / plant (0.535). The associations among number of capsules / plant and each of stem diameter (0.563), straw yield / plant (0.587), seed yield / plant (0.615), no. of seeds / plant (0.793) and fruiting zone length (0.638) were highly significant positive. The r value among stem diameter and each of straw yield / plant (0.756), seed yield / plant (0.621) and no. of seeds / plant (0.698) were highly significant positive.

Table 3. Simple correlation coefficients between ten flax characters (combining over the two seasons).

Characters	1	2	3	4	5	6	7	8	9
1-Plant height (cm)									
2-Technical length (cm)	0.934 **								
3-NO.of opical branches	0.355	0.251							
4-No. of capsules/plant	-0.007	-0.257	0.735 **						
5-No.of seeds/capsule	-0.025	0.134	-0.195	-0.310					
6-Stem diameter (mm)	0.051	-0.022	0.781 **	0.563 **	0.241				
7-Straw yield/plant	0.646 **	0.504 *	0.899 **	0.587 **	-0.030	0.756 **			
8-Seed yield/plant	-0.583 *	-0.739 **	0.374	0.615 **	-0.215	0.621 **	0.171		
9-No.of seeds/plant	-0.187	-0.333	0.535*	0.793 **	0.310	0.698 **	0.454 *	0.583 **	
10-Fruiting zone length(cm)	0.412	0.059	0.352	0.638 **	-0.413	0.198	0.519 *	0.258	0.328

*,** Significant at 0.05 and 0.01 levels of probability, respectively.

The correlation coefficient values were only significant positive between straw yield / plant and either no. of seeds / plant (0.454) or fruiting zone length (0.519). the r value recorded highly significant positive between seed yield / plant and no. of seeds / plant (0.583). These results are in agreement with those obtained by Mishra and Singh (1992), Abo El-Zahab *et al.*, (1994), El-Shimy *et al.*, (1998), Zahana (2004) and Abo-Kaied *et al.*, (2006).

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استجابة بعض التراكيب الوراثية من الكتان لتراكيب من السماد النيتروجيني والفسفوري والبوتاسي مصطفى أمين عبد الدايم قسم بحوث محاصيل الألياف - معهد المحاصيل الحقلية-مركز البحوث الزراعية-الجيزة-

أقيمت تجربتان حقليتان بمحطة البحوث الزراعية بالجيزة -محافظة الغربية- مركز البحوث الزراعية خلال الموسمين ٢٠٠٤/٢٠٠٥، ٢٠٠٥/٢٠٠٦ وذلك لدراسة استجابة ستة تراكيب وراثية من الكتان (سحا ١ ، سحا ٢ ، سحا ٣، سحا ٤، سحا ٥، سحا ٦) وثلاثة معاملات من السماد النيتروجيني والفسفوري والبوتاسي (٠ ، ٢٥ كجم نتروجين + ١٥ كجم خامس أكسيد الفوسفور + ٢٤ كجم أكسيد البوتاسيوم ، ٦٠ كجم نتروجين + ٣٠ كجم خامس أكسيد الفوسفور + ٢٤ كجم أكسيد البوتاسيوم) يمكن تلخيص أهم النتائج المتحصل عليها كما يلي :-

- 1- أشارت النتائج الي ان صنف الكتان سحا ١ أعلى المتوسطات ومتفوقا علي التراكيب الوراثية الأخرى في صفات محصول القش للقدان وكذلك للنبات، والطول الكلي، والطول الفعال، ومحصول الألياف / فدان في حين سجلت السلالة ٢/١/٢/٣٣٦ أقل المتوسطات لمعظم صفات القش الاقتصادية.
- 2- أظهرت النتائج الي ان صنف الكتان سحا ٢ المكانة الأولى وتفوق علي باقي التراكيب الوراثية في كل صفات البذرة المدروسة (محصول البذور للقدان وكذلك للنبات، عدد الكبسولات للنبات، عدد البذور بالكبسولة وكذلك للنبات، وعدد الأفرع القمية).
- 3- لقد وجد ان مخلوط السماد النيتروجيني والفسفوري والبوتاسي أدى إلى زيادة متدرجة في صفتي القش والبذور ومكوناتهما وذلك بزيادة المستوي من العناصر من الأول وحتى أعلى مستوي من السماد.
- 4- كان التفاعل بين التراكيب الوراثية ومستويات التسميد المختلفة معنويا علي صفات محصول القش/فدان، محصول الألياف / فدان، محصول البذور/فدان، عدد الكبسولات/نبات، وعدد البذور / كبسولة.
- 5- أظهر معامل الارتباط بين ارتفاع النبات وكل من الطول الفعال ومحصول القش /نبات ارتباط عالي المعنوية وكذلك بين الطول الفعال ومحصول القش/نبات، وكذلك بين عدد الأفرع القمية وكل من عدد الكبسولات /نبات، وسمك الساق، ومحصول القش /نبات. في حين كان الارتباط معنويا فقط بين عدد البذور/نبات. هذا بالإضافة إلى أن العلاقة بين عدد الكبسولات/نبات وكل من سمك الساق، ومحصول القش / نبات، ومحصول البذور / نبات، وطول المنطقة الثمرية موجب وعالي المعنوية.

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