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RESPONSE OF SOME FLAX GENOTYPES TO MINERAL NITROGEN LEVELS AND BIO-FERTILIZER

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ABSTRACT

This investigation was conducted at Gemmaza Agric. Res. Station Gharbia Governorate, A.R.C., Egypt during the two successive seasons of 2003/04 and 2004/05 to study the effect of inoculation with bio-fertilizer on yield and yield components of two commercial cultivars namely Sakha1 and Sakha2 under graded levels of nitrogen fertilization. A spit-split plot design with four replications was used with varieties (V), Sakha1 and Sakha2 as main plots, whereas mineral nitrogen (N) levels (0,15,30 and 45 kg/fed) as sub plots while the sub-sub plots were devoted to bio-fertilization (B) treatments.

The most important results could summarized as follow:

1- Combined data revealed that significant difference between flax cultivars for all characters under study. Sakha1 gave the highest values of plant height, technical stem length, straw weight / plant, straw yield / fed, fiber yield / fed, fiber percentage, fiber length and fiber fineness, while Sakha2 gave the highest values of each No. of capsules / plant, No. of seeds / capsule, 1000-seed weight, seed weight / plant seed yield / fed, oil yield/ fed and oil percentage.

2- The nitrogen fertilizer showed significantly increased most characters under study by increasing nitrogen level from zero to 45 kg N / fed, while there was no significant effect on No. of seeds / capsule. Whereas, fiber fineness gradually decreased as N level was increased. There was a trend of coarseness of fiber due to increased N level until 45 kg N / fed.

3- Bio-fertilizer application significantly increased plant height, technical stem length, straw weight / plant, straw yield / fed, fiber yield / fed, No. of capsules / plant, No. of seeds / capsule , 1000-seed weight, seed weight / plant, seed yield / fed, oil yield / fed and also, the bio-fertilization significantly increased oil percentage fiber percentage and fiber length. In contrast, bio-fertilizer caused decreases in fiber fineness.

4- The interactions between the studied factors were not significant, except N x V interaction had a significant effect on straw weight / plant, 1000-seed weight, fiber percentage and fiber length. Moreover, V x N x B for straw weight / plant, straw yield / fed, fiber yield / fed, No. of capsules / plant, 1000-seed weight, seed weight / plant, seed yield / fed and oil yield / fed. It can be recommended that cultivation of flax with soil inoculation by bio-fertilizer with nitrogen level of 30 kg N /fed in order to get of the highest straw yield and fiber yield with Sakha1 as well as get of the highest seed yield and oil yield /fed with Sakha2 under the environmental conditions of the study.

Keywords: Flax varieties, Bio-fertilizer, N-fertilizer.

INTRODUCTION

Flax (*Linum usitatissimum* L.) was one of the earliest plants used in the manufacture of clothing. Flax has been grown since the beginnings of civilization, and people all over the world have celebrated its usefulness throughout the ages, both as a food and in the manufacture of clothing. In Egypt, flax is grown as a dual purpose crop for its oil and fiber. Improved yield and quality of flax could be achieved by using high yielding cultivars as well as suitable cultural practices. Variation among flax genotypes regarding yield,

yield components and quality was reported by several workers such as Mourad *et al*, (1990), Abo El-Zahab *et al*, (1994), El-Sweify *et al*, (1996), Zahana (2004) and Abd El-Haleem (2006).

Concerning the effect of nitrogen fertilization on flax yield and quality of flax has been studied by many workers Momtaz *et al*, (1981), Hella *et al*, (1988), El-Nimer *et al*, (1997) and Zahana (2004) showed that increasing nitrogen level from 50 to 80 N / fed increased yield and yield components.

Recently, much interest is focused on using bio-fertilizers to minimize consumption of chemical nitrogen fertilization, to decrease production costs and reduce environmental pollution. Afify *et al*, (1994) reported maximum values for seed and straw yield / fed due to dual fertilization of flax with NPK and Azotobacter and Bacellus. Abd El-Haleem (2006) found that the soil inoculating by Nitrobin increased seed, straw and oil yields / fed of flax.

Thus the objective of this study was to evaluate the beneficial effect of using N bio-fertilizer as alternate or N fertilization on yield and quality of two commercial cultivars, Sakha1 and Sakha2.

MATERIALS AND METHODS

Two field experiments were performed at El-Gemmeza Agric. Res. Station, Gharbia Governorate, A.R.C., Egypt during the two successive seasons of 2003/2004 and 2004/2005 to study the effect of inoculation with bio-fertilizer (Rhizobacteren) on yield and yield components of two flax varieties under graded nitrogen levels.

A split-split plot design with four replications was used for each trial. The main plots were devoted to the two commercial flax varieties namely Sakha1 and Sakha2. The sub-plots were devoted to nitrogen levels (0, 15, 30 and 45 kg N/ fed.), while the sub-sub plots were assigned to bio-fertilization treatments i.e. two inoculation treatments with bio-fertilization (+B) and non-bio-fertilization (-B). Each sub-plot was 2 x 3 meters (1/700 fed) with 10 rows, 20 cm apart. Flax was sown on November 17 and 19 in the first and second seasons, respectively. The preceding crop was maize (*Zea mays* L.) in both seasons. Flax seeds were drilled in rows at the plant density rate 2000 seeds/m^2. Nitrogen fertilizer was applied in the form of Urea (46%) was added in two equal doses (after 30 and 55 days from planting). Soil was inoculated by bio-fertilization just after planting. The bio-fertilizer is prepared by “Soil Microbiology Department Soil and Water Institute, Agricultural Research Center, Giza”. Other agricultural practices were applied as recommended. The soil type was clay loam with organic matter of 2.08 and 2.03 %, available nitrogen 24.35 and 26.50 ppm, CaCO3 of 1.49 and 1.65% and pH value of 8.10 and 8.01 in the first and second seasons, respectively.

At harvest, ten guarded plants were taken at random from each sub-sub plot to determine yield, yield component and some quality characters of flax. While straw, seed yield per fed were determined on sub-sub plot area basis.

Characters studied:

Straw yield and related characters: Plant height (cm), technical stem length(cm), straw weight (g) / plant, straw yield (ton) / fed and fiber yield (kg) / fed (fed = 0.42 ha).

Seed yield and related characters: No. of capsules / plant, No. of seeds / capsule, 1000-seed weight (g), seed weight (g) / plant, seed yield (kg) / fed and oil yield (kg) / fed.

Technological characters: Oil percentage was determined using the procedure described by A.O.A.C. (2000), fiber percentage, fiber length (cm) and fiber fineness (Nm) were determined according to the technique described by Rodwan and Momtaze (1966).

Statistical analysis:

All data were statistically analyzed by the analysis of variance method according to Snedecor and Cochran (1982), differences between means were tested by L.S.D. at the level of 0.05. A combined analysis was performed for each character over the two season (Le Clerg *et al.,*1966).

RESULTS AND DISCUSSION

1- Straw, fiber yields and their related characters:

1-1- Varietal effect:

Combined analysis of the two seasons (2003/04) and (2004/05) are presented in Table (1), revealed significant difference among flax cultivars for plant height, technical length, straw weight / plant, straw yield / fed and fiber yield / fed. Sakha1 ranked first and surpassed Sakha2 with mean values for plant height (82.45 and 79.78 cm), technical length (67.35 and 63.29 cm), straw weight / plant (2.25 and 2.09 g), straw yield / fed (2.766 and 2.642 ton) and fiber yield / fed (492.33 and 458.39 kg) for Sakha1 and Sakha2, respectively. The present results are mainly due to the differences in the genetical varieties constitution under study. The results are in agreement with those obtained by Mourad *et al*, (1990), Abo E-Zahab *et al*, (1994), El-Sweify *et al*, (1996), El-Shimy *et al*, (1998), Mostafa *et al*, (1998), Zahana (2004) and Abd El-Haleem (2006).

1-2-Mineral nitrogen effect:

The nitrogen levels had significant effect on plant height, technical length, straw weight / plant, straw yield / fed and fiber yield / fad. There was a gradual increase with increasing N level toward the highest dose of 45 kg N / fed. The highest values of plant height (86.23 cm), technical length (69.14 cm), straw weight / plant (3.03 g), straw yield / fed (3.432 ton) and fiber yield / fed (629.21 kg) were obtained by applying highest N level of 45 kg N / fed. The important role of nitrogen in building up protoplasm and proteins, which induce cell division and merestemic activity and increase cell number and size which finally increased flax growth and its yield. Similar findings were reported by Momtaz *et al*, (1981), Hella *et al*, (1988), El-Nimer *et al*, (1997), Zahana (2004) and Abd El-Haleem (2006).

T1

1-3- Bio-fertilization:

Data in Table (1) showed that bio-fertilizer application significantly affected plant height (84.19m), technical length (67.58 cm), straw weight / plant (2.61 g), straw yield / fed (2.846 ton) and fiber yield / fed (510.96 kg). Generally, the bio-fertilizer which was used in this study considered a very important source of nitrogen in comparison with non bio-fertilization, this behaviour may be due to stimulation of the activity of ouxins, enzymes in plants which reflect on growth by increasing vital processes. Similar results were reported by Sarig *et al*, (1984), Omer *et al*, (1991), Afify *et al*, (1994), Hamed (1998), El Gazzar (2000), Abd El-Samie and Zedan (1998), El-Deeb (2002) and Abd El-Haleem (2006).

1-4- Interaction effect:

Data in Table (1) revealed that all interactions between the studied factors were not significant, except first order interaction (N x V) for straw weight / plant as well as second order interaction (V x N x B) for straw weight / plant, straw yield / fed and fiber yield / fed. The highest values of straw weight / plant (3.46 and 3.42 g) without significant differences among them, straw yield / fed (3.587 and 3.573 ton) and fiber yield / fed (669.67 and 665.70 kg) were obtained from Sakha1 fertilized with 45 and 30 Kg N / fed, respectively and treated with bio-fertilizer. This indicates that the response Sakha1 cultivar with fertilized 45 Kg N / fed as well as soil inoculation bio-fertilizer was similar with combination (Sakha1 with 30 kg N fed as well as bio-fertilizer) for the aforementioned characters.

2- Seed, oil yields and their related characters:

2-1- Varietal effect:

Table (2) showed that there were significant differences between the two flax cultivars under study in No. of capsules / plant, No. of seeds/ capsule, 1000-seed weight, seed weight / plant, seed yield / fed and oil yield / fed. Sakha2 ranked first regarding No. of capsules / plant (9.38), No. of seeds / capsule (7.03), 1000-seed weight (9.53 g), seed weight / plant (0.58 g), seed yield / fed (430.77 kg) and oil yield/ fed (172.12 kg). The present results are mainly due to the differences in the genetical constitution of the tested genotypes under study. The above mentioned results are in harmony with those obtained by Mourad *et al*, (1990), Abo E-Zahab *et al*, (1994), El-Sweify *et al*, (1996), El-Shimy *et al*, (1998), Mostafa *et al*, (1998), Zahana (2004) and Abd El-Haleem (2006).

2-2-Mineral nitrogen effect:

Data in Table (2) showed that nitrogen fertilizer significantly increased the following five seed traits and reached their maximum estimates when applied 45 kg N/fed with the averages for No. of capsules / plant (11.22), 1000-seed weight (10.01 g), seed weight / plant (0.71 g), seed yield / fed (555.87 kg) and oil yield / fed (222.68 kg), while there was no significant effect on No. of seeds / capsule. It seams that high nitrogen doses improved flax growth. Similar findings were reported by Momtaz *et al*, (1981), Hella *et al*, (1988), El Nimer *et al*, (1997), El-Sweify *et al*, (1996), Zahana (2004) and Abd El-Haleem (2006).

T2

2-3- Bio-fertilization:

The results showed that soil inoculation with bio-fertilizers affected No. of capsules / plant (9.77), No. of seeds / capsule (6.98), 1000-seed weight (9.41 g), seed weight / plant (0.60 g), seed yield / fed (446.42 kg) and oil yield / fed (177.14 kg). The positive effect of soil inoculation may due to stimulation of plant hormones, consequently best growth. These results are in harmony with those of Sarig *et al*, (1984), Afify *et al*, (1994), El-Deeb (2002) and Abd El-Haleem (2006).

2-4- Interaction effect:

The results showed that all the interactions had no significant effects except N x V interaction for 1000-seed weight as well as V x N x B for No. of capsules / plant, 1000-seed weight, seed weight / plant, seed yield / fed and oil yield / fed. The highest values of No. of capsules / plant (12.77 and 11.67), 1000-seed weight (10.64 and 10.38 g), seed weight / plant (0.90 and 0.89 g), seed yield / fed (592.83 and 565.33 kg) and oil yield / fed (240.12 and 228.45 kg) were obtained from Sakha2 fertilized with (45 and 30 kg N / fed, respectively and treated with bio-fertilizer. This mean that the combination, Sakha2 + 45 Kg N / fed + soil inoculation bio-fertilizer and the combination, Sakha2 with 30 kg N fed as well as bio-fertilizer was the same for the aforementioned characters.

3- Technological characters:

3-1- Varietal effect:

Combined mean values for technological characters of two flax cultivars are presented in Table (3). Flax cultivars differed significantly in their technological characters *i.e.*, oil percentage, fiber percentage, fiber length and fiber fineness. Sakha2 gave the highest value of oil percentage (39.70%), while the highest values of fiber percentage (17.59%), fiber length (65.06 cm) and fiber fineness (149.58 Nm) were obtained by Sakha1 cultivar. The present results are mainly due to differences in the genetical constitution of the tested cultivars under study. These results are in harmony with those obtained by El Shimy *et al*, (1998), Mostafa *et al*, (1998), Zahana (2004) and Abd El-Haleem (2006).

3-2- Mineral nitrogen effect:

Data in Table (3) showed that nitrogen levels had significant effects on all the four technological traits studied (oil percentage, fiber percentage, fiber length and fiber fineness). Increasing N level up to 45 kg N / fed increased oil percentage (40.02%), fiber percentage (18.33%) and fiber length (66.33 cm), while fiber fineness gradually decreased as N level was increased by means that more coarse. There was a trend of coarseness of fiber due to increase N level until 45 kg N / fed. It seems that high nitrogen doses improved flax growth and delayed maturity in the same time, the more sedimentation of cellulose substance in the secondary wall in fiber formation consequently would affect fineness towards heavier weight for the given fiber length to record metrical number (Nm). Similar findings were reported by Momtaz *et al*, (1981), Hella *et al*, (1988), El Nimer *et al*, (1997), El-Sweify *et al*, (1996), Zahana (2004) and Abd El-Haleem (2006).

T3

3-3- Bio-fertilization:

Data indicated that bio-fertilization significantly increased oil percentage (39.50%), fiber percentage (17.74%) and fiber length (65.44 cm). In contrast, bio-fertilizer caused decreases in fiber fineness. These results are in harmony with those obtained by Abd El Samie and Zedan (1998), El-Gazar (2000), and Abd El-Haleem (2006).

3-4- Interaction effect:

Data in Table (3) revealed that all interactions combination between the studied factors were not significant, except V x N interaction for fiber percentage and fiber length. The highest values of fiber percentage (18.67%) and fiber length (70.12 cm) were obtained from Sakha1 fertilized with 45 kg N / fed and inoculation with bio-fertilizer.

General conclusions:

In general, It can be recommended that cultivation of flax with soil inoculation by bio-fertilizer with nitrogen level of 30 kg N / fed in order to get the highest straw yield and fiber yield with Sakha1 as well as get the highest seed yield and oil yield / fed with Sakha2 under the environmental conditions of the study.

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استجابة بعض التراكيب الوراثية من الكتان لمستويات مختلفة من التسميد النيتروجيني والحيوي

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أجريت تجربتان حقليتان في محطة البحوث الزراعية بالجميزة – م.الغربية ، خلال موسمي ٢٠٠٣/٠٤ ، ٢٠٠٤/٠٥ لدراسة تأثير استخدام أربعة مستويات من التسميد النيتروجيني المعدني (٠، ١٥ ، ٣٠ ، ٤٥ كجم/فدان) مع التلقيح بالسماد الحيوي (ريزوباكترين) علي المحصول وصفات الجودة في الكتان علي صنفي الكتان (سخا ١ ، سخا ٢). وكان التصميم المستخدم القطع المنشقة مرتين ذات الأربع مكررات حيث خصصت القطع الرئيسية للأصناف بينما القطع الشقية الأولى خصصت لمستويات التسميد النيتروجيني والقطع المنشقة مرتين للتسميد الحيوي. ويمكن تلخيص أهم النتائج فيم يلي:-

أشارت النتائج الخاصة بالتحليل التجميعي للبيانات إلي وجود اختلافات معنوية بين الصنفين تحت الدراسة . كما أعطى الصنف سخا١ أعلى قيم للطول الكلى ، والطول الفعال، ووزن القش للنبات، ومحصول القش للفدان ، ومحصول الألياف للفدان ، والنسبة المئوية للألياف ، وطول الألياف ، والنعومة . بينما الصنف سخا٢ أعطى أعلى قيم لعدد الكبسولات للنبات ، وعدد البذور بالكبسولة ، ووزن الألف بذرة ، ووزن البذور للنبات ، ومحصول البذور للفدان ، ومحصول الزيت للفدان ، والنسبة المئوية للزيت .

كما أظهر التسميد الآزوتي المعدني زيادة معنوية لمعظم الصفات تحت الدراسة عند التدرج من صفر إلي ٤٥ كجم/فدان بينما نعومة الألياف تتناقص بزيادة مستويات التسميد النيتروجيني .

كما أظهرت النتائج أن التسميد الحيوي أدى إلي زيادة معنوية في الطول الكلي ، والطول الفعال ، ووزن القش للنبات ، ومحصول القش للفدان ، ومحصول الألياف للفدان ، وعدد الكبسولات للنبات ، وعدد البذور بالكبسولة ، ووزن الألف بذرة ، ووزن البور للنبات ، ومحصول البذور للفدان ، ومحصول الزيت للفدان ، والنسبة المئوية للزيت ، والنسبة المئوية للألياف ، وطول الألياف وعلى العكس من ذلك أدى التسميد الحيوي إلى نقص في نعومة الألياف .

أشارت نتائج التفاعلات بين العوامل المختلفة تحت الدراسة إلى عدم معنويتها ماعدا تفاعل (الأصناف x التسميد النيتروجيني) حيث كان معنويا مع محصول القش/ نبات، ووزن الألف بذرة والنسبة المئوية للألياف وكلك طول الألياف . كذلك التفاعل الثلاثي (أصناف x نيتروجين x تسميد حيوي) كان معنويا لصفات وزن القش/نبات وعدد الكبسولات/نبات ووزن الألف بذرة، ووزن البذور/ نبات وكل من محصول القش والألياف والبذور والزيت /فدان .

وأنه يمكن التوصية عند زراعة الكتان بتلقيح التربة بالسماد الحيوي مع ٣٠ وحدة سماد نيتروجيني للفدان مع الصنف سخا١ للحصول على أعلى محصول من القش والألياف، والصنف سخا٢ للحصول على أعلى محصول من البذور والزيت وذلك تحت الظروف البيئية لهذه الدراسة .

Table 1. Effect of bio-fertilization (B) and mineral nitrogen (N) levels on straw, fiber yields and their related characters for two flax varieties (combined analysis of the two seasons).

Varieties	*N levels*	Plant height (cm)			Technical stem Length (cm)			Straw weight/plant(g)			Straw yield/fed(ton)			Fiber yield/fed (kg)		
		(+B)	(-B)	Means	(+B)	(-B)	Means	(+B)	(-B)	Means	(+B)	(-B)	Means	(+B)	(-B)	Means
Sakha 1	0 kg	79.25	73.48	76.37	65.52	61.05	63.28	1.50	0.78	1.14	1.915	1.571	1.743	321.25	241.83	281.54
	15 kg	83.78	78.07	80.93	68.58	63.73	66.16	2.43	1.23	1.83	2.577	2.260	2.419	456.68	382.90	419.79
	30 kg	88.45	80.88	84.67	71.98	65.63	68.81	3.42	2.33	2.88	3.573	3.215	3.394	665.20	571.33	618.27
	45 kg	91.80	83.88	87.84	73.95	68.37	71.16	3.46	2.84	3.15	3.587	3.433	3.510	669.67	629.75	649.71
	Means	**85.82**	**79.08**	**82.45**	**70.01**	**64.70**	**67.35**	**2.70**	**1.79**	**2.25**	**2.913**	**2.620**	**2.766**	**528.20**	**456.45**	**492.33**
Sakha 2	0 kg	75.80	71.83	73.82	61.23	57.87	59.55	1.34	0.68	1.01	1.771	1.466	1.619	289.37	223.92	256.64
	15 kg	81.10	75.37	78.23	64.08	60.67	62.38	2.26	1.23	1.75	2.473	2.198	2.336	422.62	353.23	387.93
	30 kg	85.43	79.50	82.47	67.48	62.73	65.11	3.23	2.22	2.73	3.435	3.086	3.261	628.85	531.73	580.29
	45 kg	87.93	81.27	84.60	69.80	64.42	67.11	3.26	2.53	2.89	3.438	3.268	3.353	634.07	583.32	608.69
	Means	**82.57**	**76.99**	**79.78**	**65.15**	**61.42**	**63.29**	**2.52**	**1.66**	**2.09**	**2.779**	**2.505**	**2.642**	**493.73**	**423.05**	**458.39**
Mean for bio-fertilizer		84.19	78.04	81.11	67.58	63.06	65.32	2.61	1.73	2.17	2.846	2.562	2.704	510.96	439.75	475.36
Mean for Nitrogen levels																
	0 kg	77.53	72.66	75.09	63.38	59.46	61.42	1.42	0.73	1.07	1.843	1.519	1.681	305.31	232.88	269.09
	15 kg	82.44	76.72	79.58	66.33	62.20	64.27	2.35	1.23	1.79	2.525	2.229	2.377	439.65	368.07	403.86
	30 kg	86.94	80.19	83.57	69.73	64.18	66.96	3.33	2.27	2.80	3.504	3.151	3.327	647.03	551.53	599.28
	45 kg	89.87	82.58	86.23	71.88	66.39	69.14	3.36	2.68	3.03	3.513	3.351	3.432	651.87	606.53	629.21

L.S.D. 5% level of significance for:						
Varieties (V)	2.510		2.910		0.130	0.069	22.110
Nitrogen (N)	2.140		2.020		0.150	0.072	25.120
bio-fertilization (B)	5.120		3.110		0.270	0.082	31.110
V x N	NS		NS		0.370	NS	NS
V x B	NS		NS		NS	NS	NS
N x B	NS		NS		NS	NS	NS
V x N x B	NS		NS		0.15	0.033	11.41

(+B),(-B) = With and without bio-fertilization ,respectively.
NS = Non- Significant

Table 2. Effect of bio-fertilization (B) and mineral nitrogen (N) levels on seed, oil yields and their related characters for two flax varieties (combined analysis of the two seasons).

Varieties	N levels	No. of capsules / plant			No. of seeds/ capsule			1000-seed weight (g)			Seed weight / plant (g)			Seed yield / fed.(kg)			Oil yield / fed.(kg)		
		(+B)	(-B)	Means	(+B)	(-B)	Means	(+B)	(-B)	Means	(+B)	(-B)	Means	(+B)	(-B)	Means	(+B)	(-B)	Means
Sakha 1	0 kg	6.60	5.40	6.00	5.52	4.89	5.21	8.32	8.16	8.24	0.27	0.18	0.23	281.33	238.67	260.00	107.82	90.08	98.95
	15 kg	8.35	6.83	7.59	6.33	5.66	6.00	8.65	8.39	8.52	0.46	0.30	0.38	369.83	319.83	344.83	144.32	122.43	133.38
	30 kg	10.40	8.33	9.37	7.24	6.31	6.78	9.47	9.08	9.28	0.68	0.43	0.55	542.33	474.17	508.25	214.58	183.48	199.03
	45 kg	11.53	9.93	10.73	7.31	6.66	6.99	9.72	9.55	9.64	0.68	0.55	0.62	548.83	524.33	536.58	217.93	205.33	211.63
	Means	**9.22**	**7.62**	**8.42**	**6.60**	**5.88**	**6.24**	**9.04**	**8.80**	**8.92**	**0.52**	**0.36**	**0.44**	**435.58**	**389.25**	**412.42**	**171.16**	**150.33**	**160.75**
Sakha 2	0 kg	7.65	6.02	6.84	6.13	5.38	5.76	8.57	8.25	8.41	0.36	0.22	0.29	291.17	245.83	268.50	113.00	93.72	103.36
	15 kg	9.15	7.77	8.46	7.33	6.60	6.97	9.53	9.03	9.28	0.58	0.40	0.49	379.67	330.50	355.08	150.85	128.65	139.75
	30 kg	11.67	9.35	10.51	7.94	7.28	7.61	10.38	9.75	10.07	0.89	0.62	0.76	565.33	483.33	524.33	228.45	194.83	211.64
	45 kg	12.77	10.65	11.71	8.00	7.59	7.80	10.64	10.11	10.38	0.90	0.70	0.80	592.83	557.50	575.17	240.12	227.32	233.72
	Means	**10.31**	**8.45**	**9.38**	**7.35**	**6.71**	**7.03**	**9.78**	**9.29**	**9.53**	**0.68**	**0.48**	**0.58**	**457.25**	**404.29**	**430.77**	**183.11**	**161.13**	**172.12**
Mean for bio-fertilizer		9.77	8.04	8.90	6.98	6.30	6.64	9.41	9.04	9.22	0.60	0.42	0.51	446.42	396.77	421.59	177.13	155.73	166.43
Mean for Nitrogen levels																			
	0 kg	7.13	5.71	6.42	5.83	5.14	5.48	8.44	8.21	8.33	0.32	0.20	0.26	286.25	242.25	264.25	110.41	91.90	101.15
	15 kg	8.75	7.30	8.03	6.83	6.13	6.48	9.09	8.71	8.90	0.52	0.35	0.44	374.75	325.17	349.96	147.58	125.54	136.56
	30 kg	11.04	8.84	9.94	7.59	6.80	7.19	9.93	9.42	9.67	0.78	0.52	0.65	553.83	478.75	516.29	221.52	189.16	205.34
	45 kg	12.15	10.29	11.22	7.66	7.13	7.39	10.18	9.83	10.01	0.79	0.63	0.71	570.83	540.92	555.87	229.03	216.33	222.68

L.S.D. 5% level of significance for:

Varieties (V)	0.800	0.470	0.230	0.080	12.250	7.140
Nitrogen (N)	0.900	NS	0.250	0.040	14.130	10.190
bio-fertilization (B)	1.220	0.350	0.220	0.090	24.130	11.220
V x N	NS	NS	0.390	NS	NS	NS
V x B	NS	NS	NS	NS	NS	NS
N x B	NS	NS	NS	NS	NS	NS
V x N x B	1.41	NS	0.32	0.04	27.73	11.94

(+B),(-B) = With and without bio-fertilization ,respectively. NS = Non- Significant

Table 3. Effect of bio-fertilization (B) and mineral nitrogen (N) levels on some technological characters for two flax varieties (combined analysis of the two seasons).

Varieties	*N levels*	Oil percentage (%)			Fiber percentage(%)			Fiber length (cm)			Fiber Fineness (Nm)		
		(+B)	(-B)	Means	(+B)	(-B)	Means	(+B)	(-B)	Means	(+B)	(-B)	Means
Sakha 1	0 kg	38.31	37.70	38.01	16.77	15.88	16.33	63.40	59.00	61.20	155.50	157.15	156.33
	15 kg	39.03	38.28	38.65	17.71	16.92	17.32	66.33	61.85	64.09	151.15	154.67	152.91
	30 kg	39.57	38.76	39.16	18.62	17.78	18.20	69.90	63.80	66.85	145.20	148.03	146.62
	45 kg	39.62	39.16	39.39	18.67	18.34	18.51	70.12	66.05	68.08	141.15	143.77	142.46
	Means	**39.13**	**38.47**	**38.80**	**17.94**	**17.23**	**17.59**	**67.44**	**62.68**	**65.06**	**148.25**	**150.91**	**149.58**
Sakha 2	0 kg	38.81	38.12	38.46	16.33	15.27	15.80	59.35	55.67	57.51	150.41	154.65	152.53
	15 kg	39.73	38.91	39.32	17.08	16.06	16.57	62.25	58.85	60.55	146.30	149.78	148.04
	30 kg	40.41	40.29	40.35	18.31	17.23	17.77	65.58	60.65	63.12	139.37	143.70	141.54
	45 kg	40.51	40.79	40.65	18.44	17.85	18.15	66.63	62.50	64.57	136.37	140.22	138.30
	Means	**39.87**	**39.53**	**39.70**	**17.54**	**16.60**	**17.07**	**63.45**	**59.42**	**61.44**	**143.11**	**147.09**	**145.10**
Mean for bio-fertilizer		39.50	39.00	39.25	17.74	16.92	17.33	65.44	61.05	63.25	145.68	149.00	147.34
Mean for Nitrogen levels													
	0 kg	38.56	37.91	38.24	16.55	15.58	16.06	61.38	57.34	59.36	152.96	155.90	154.43
	15 kg	39.38	38.59	38.99	17.40	16.49	16.94	64.29	60.35	62.32	148.73	152.23	150.48
	30 kg	39.99	39.53	39.76	18.47	17.51	17.99	67.74	62.23	64.98	142.29	145.87	144.08
	45 kg	40.06	39.97	40.02	18.56	18.10	18.33	68.37	64.28	66.32	138.76	142.00	140.38

Varieties (V)	0.450	0.210	1.540	2.410
Nitrogen (N)	0.200	0.250	1.320	2.140
bio-fertilization (B)	0.320	0.410	2.120	3.110
V x N	NS	0.450	2.320	NS
V x B	NS	NS	NS	NS
N x B	NS	NS	NS	NS
V x N x B	NS	NS	NS	NS

(+B),(-B) = With and without bio-fertilization ,respectively.
NS = Non- Significant