RESPONSE OF FLAX TO POTASSIUM AND NITROGEN FERTILIZATION UNDER SANDY SOIL CONDITIONS

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(Manuscript received 3 March 1998)

Abstract

The main objective of this study is to improve yield, yield components and some technological characters of Giza 7 flax variety under sandy soil of Ismailia Res. Stat., A.R.C., during 1994/1995 and 1995/1996 seasons. The treatments were three levels of potassium (24, 36 and 48 kg. K2O/fad.) and also three levels of nitrogen (50, 60 and 70 kg. N. / fad.).

Results showed that:

1. Straw yield and its related characters significantly increased with increasing potassium levels from 24 up to 48 kg. K2O/fad. except fiber fineness which record a significant reduction with increasing potassium levels. The increases in nitrogen levels gave the same trend in relation to straw yield and its related charcters.
2. There was a significant increase by increasing K2O levels in each of number of capsules/plant, number of seeds/capsule, number of seed/plant, seed yield/plant as well as per fad. On the other hand, the high levels of nitrogen (60 and 70 kg. N/fad.) caused a significant increase in seed yield and its related characters except on seed index and oil percentage.
3. The interaction between potassium and nitrogen fertilization was significant regarding to straw, seed yield and their related characters except on number of capsules per plant, seed index and oil percentage.

INTRODUCTION

Flax ranked first among the bast fiber crops in Egypt. The extention of flax cultivating area in Egypt controlled by many factors, the main of them is the competition of other winter crops such as wheat, clover, barley and faba bean etc... Therefore, the main solution is to increase flax production through the use of new developed varieties of high yielding ability with application of the best agronomic treatments, among of these are potassium and nitrogen fertilization which play an improtant role to increase flax yield and quality. Moreover, the newly reclaimed

soil land could be considered as another solution for increasing flax area.

The main goal of this work is to investigate yield, yield components and quality of Giza 7 flax variety as affected by potassium and nitrogen fertilizer under sandy soil using a sprinkler irrigation system.

Many workers have studied the effect of potassium levels on yield, yield components and quality of flax such as Hella et al. (1988), Dixit and Sharma (1993), Suratman and Mouludi (1993) and El-Sweify and Mostafa (1996), they reported that potassium caused an increase in flax yield and its components in addition to fiber and seed quality. In relation to nitrogen fertilization many investigators observed that these elements play a great role in plant growth as a result of affecting many physiological processes in plant life. Nuttall and Malhi (1991), Salwa and El-Farouk (1991), Easson and Long (1992), El-Shimy et al. (1993), Nada (1995) and Jain et al. (1995), reported that nitrogen application caused an increase in flax production as well as the quality of fiber and seed.

The importance of anatomical studies for flax stem as an indicator for most fiber quality characters was indicated by many investigators such as El-Shimy et al. (1993), El-Sweify (1993), Mostafa (1994) and El-Shourbagy et al. (1995).

MATERIALS AND METHODS

These trials were conducted twice in 1994/1995 and 1995/1996 seasons at Ismailia Agric. Res. Stat., Ismailia Governorate, Egypt, to study the effect of potassium, nitrogen levels and their combinations on the productivity and quality of Giza 7 flax variety. The experimental soil was sandy and the preceding crop was peanut in both seasons. Mechanical and chemical analysis of the experimental soil in both seasons are presented in Table (1).

Table 1. Some of mechanical and chemical properties of the experimental soil.

Variables	1994 / 1995	1995 /1996
	Mechanical analysis	
Coarse sand %	63.10	60.75
Fine sand %	34.95	37.50
Silt and clay %	1.95	1.75
	Chemical analysis	
Available N. PPM.	25.30	24.50
Available P. PPM.	3.05	2.75
Available K. PPM.	31.65	33.14

Treatments were arranged in split-plot design of four replications, the three potassium levels were arranged in the main plots i.e. (A_1) 24 kg. K_2O/fad., (A_2) 36 kg. K_2O/fad. and (A_3) 48 . K_2O/fad., while the three nitrogen levels were located in sub-plots i.e. (B_1) 50 kg. N./fad., (B_2) 60 kg. N./fad. and (B_3) 70 kg. N./fad. The sub-plot area was 2x3 m (6 m^2) and seed of flax were cultivated in rows 20 cm. apart on 10 and 13 Nov. in the first and second seasons, respectively. Normal and agronomic practices for growing flax were followed.

At full maturit y ten guarded plants were taken at random from each plot to be used in the yield components studies. Straw, fiber and seed yield per faddan were recorded upon the whole plot.

Characters studied:

1. Straw yield and its related characters:

1. Plant height (cm).
2. Technical length (cm).
3. Main stem diameter (cm).
4. Straw yield/plant (g).
5. Straw yield/fad. (ton).
6. Fiber yield/plant (g).
7. Fiber yield/fad. (kg.).
8. Fiber length (cm).
9. Long fiber (%).
10. Fiber fineness (Nm.).

II. Seed yield and its related charcters:

1. Upper branching zone length (cm).
2. Number of capsules/plant.
3. Number of seeds/capsule.
4. Number of seeds/plant.
5. Seed index (weight of 1000 seeds in grams).
6. Seed yield/plant (g).
7. Seed yield/fad. (kg).
8. Oil percentage.

Collected data were statistically analysed according to Snedecor and Cochran (1982) and differences between means were tested by L.S.D., combined analysis was performed as described by Le Clerge et al. (1966).

Anatomical studies:

At maturity stage, four guarded plants were chosen per each treatment under study. Samples were taken from the middle part of the technical stem length. Paraffine was method was used for obtaining cross sections which stained with 0.5% safarnin and 1% light green solutions.

These cross sections were made to determine the measurements of total cross section, fiber, xylem, cortex, fiber bundle and pith areas (mm^2). Moreover, to calculated fiber, xylem, cortex and pith area as a percentage of the corresponding total cross section area and fiber index.

$$\text{Fiber index } (mm^3) = \frac{\text{fiber area/cross section x technical stem length}}{1000}$$

This study included microscopic examination as No. of fiber bundles, No. of fiber cells/bundle and fiber cell area.

RESULTS AND DISCUSSION

1. Straw yield and its related characters:

Results presented in Table (2) showed that mean values of straw yield and its related characters as affected by potassium and nitrogen fertilizer levels.

Table 2. Effect of potassium and nitrogen levels on straw yield and its related characters (Average of 1994/1995 and 1995/1996 seasons).

Treatments		K. Levels				N. levels			
Characters		24	36	48	L.S.D	50	60	70	L.S.D.
Plant height	(Cm)	91.92	94.63	98.60	3.40	91.01	94.57	99.57	4.30
Technical length	(Cm)	78.25	80.49	84.60	3.75	76.74	80.57	86.03	3.00
Main stem diameter	(mm) (cm)	1.63	1.71	1.76	0.12	1.50	1.71	1.88	0.15
Straw yield / plant	(g)	1.15	1.27	1.38	0.15	1.16	1.26	1.38	0.11
Straw yield / fad.	(ton)	2.20	2.25	2.29	0.03	2.18	2.24	2.31	0.05
Fiber yield / plant	(g)	0.20	0.24	0.27	0.04	0.21	0.23	0.26	0.02
Fiber yield / fad.	(Kg)	388.05	422.05	443.81	18.65	396.37	419.88	437.67	17.30
Fiber length	(m)	75.70	77.70	82.17	4.00	73.60	78.48	83.48	4.35
Long fiber	(%)	11.46	11.78	12.48	0.61	11.25	11.90	12.58	0.55
Fiber fineness	(Nm)	186.88	194.95	200.78	4.30	198.20	193.67	190.73	6.25

A. Effect of pstassium:

Potassium fertilizer levels had a significant effect on all straw yield and its related characters under study. However, gradual increases were detected by increasing potassium levels up to 48 kg. K2O/fad. on plant height, technical length, main stem diameter, straw yield/plant as well as per faddan, fiber yield per plant, fiber yield per faddan, fiber length and long fiber percentage. Moreover, significant decrease on fiber fineness was observed by increasing potassium dose up to 48 kg. K2O/fad. In general, the improvement and increase in flax straw yield and its related characters is due to the role of potassium element in physiological process which reflect on the all straw yield characters. Similar results were obtained by Hella et al. (1988), Dixited and Sharma (1993) and El-Sweify and Mostafa (1996).

B. Effect of nitrogen levels:

With respect to nitrogen fertilizer levels, data showed significant differences between the three nitrogen levels under study. Results indicated that there were gradual increase in each of the mean values of all characters with increasing nitrogen fertilizer levels from 50 up to 70 kg. N. /fad. except with fiber fineness trait which decreased in its mean values with increasing nitrogen levels from 50 up to 70 kg. nitrogen per faddan. Result obtained were in agreement with those obtained by El-Farouk et al. (1982), Abdalla et al. (1989), Nuttall and Malhi (1991) and Nada (1995).

It must be concluded that nitrogen increased flax growth expressed in terms of straw yield characters and it could be mentioned also that nitrogen is fundamentlly needed for flax plants under the sandy soil condition in Egypt.

C. Effect of intercation:

Potassium x nitrogen interaction significantly affected straw yield and its related characters as presented in Table (3). Moreover, combinations between potassium and nitrogen levels increased and improved straw yield and fiber quality of Giza 7 flax variety when compared with the application of either potassium or nitrogen fertilizer only.

II. Seed yield and its related characters:

The response of seed yield characters to potassium and nitrogen fertilization from the combined analysis are recorded in Table (4).

Table 3. Effect of combination of potassium and nitrogen fertilizer levels on straw yield and its related characters (Average of 1994/1995 and 1995/1996 seasons).

Treatments		A_1			A_2			A_3			L.S.D.
Characters		B_1	B_2	B_3	B_1	B_2	B_3	B_1	B_2	B_3	
Plant height	(Cm)	88.40	91.60	95.75	90.63	93.85	99.40	94.00	98.25	103.55	4.93
Technical length	(Cm)	73.00	77.90	83.85	75.63	80.05	85.80	81.60	83.75	88.45	2.01
Main stem diameter	(mm)	1.35	1.68	1.85	1.54	1.70	1.88	1.61	1.75	1.91	0.22
Straw yield / plant	(g)	1.03	1.15	1.27	1.18	1.23	1.39	1.26	1.40	1.48	0.312
Straw yield / fad.	(ton)	2.15	2.19	2.27	2.18	2.25	2.31	2.22	2.28	2.36	0.073
Fiber yield / plant	(g)	0.18	0.20	0.23	0.21	0.23	0.27	0.24	0.27	0.29	0.054
Fiber yield / fad.	(Kg)	365.50	389.82	408.83	395.14	427.50	443.52	428.46	442.32	460.67	35.81
Fiber length	(Cm)	70.30	76.55	80.25	71.00	78.50	83.60	79.50	80.40	86.60	3.73
Long fiber %		10.80	11.45	12.13	11.13	11.77	12.45	11.83	12.47	13.15	1.75
Fiber fineness	(Nm)	191.50	185.75	183.40	199.30	195.25	190.30	203.85	200.00	198.50	5.40

A_1 : 24 Kg. K_2O / fed

A_2 : 36 Kg. K_2O / fed

A_3 : 48 Kg. K_2O / fed

B_1 : 50 Kg. N / fed

B_2 : 60 Kg. N / fed

B_3 : 70 Kg. N / fed

Table 4. Effect of potassium and nitrogen levels on seed yield and its related characters (Average of 1994/1995 and 1995/1996 seasons).

Treatments	K. Levels				N. levels			
Characters	24	36	48	L.S.D	50	60	70	L.S.D.
Upp. branching zone length (cm)	13.67	14.13	14.00	N.S.	14.27	14.00	13.53	0.70
No. of capsules / plant	14.70	15.49	15.84	0.50	16.04	15.13	14.86	0.12
No. of seeds / capsule	8.08	8.45	9.02	0.71	8.38	8.53	8.65	0.10
No. of seeds / plant	116.12	138.12	164.47	24.30	131.47	139.77	147.47	6.80
Seed yield / plant	1.13	1.21	1.36	0.13	1.20	1.23	1.26	0.03
Seed yield / fad. (kg.)	386.32	390.19	396.24	8.40	380.18	392.38	400.20	7.75
Seed index (g)	8.53	8.56	8.59	N.S.	8.55	8.56	8.57	N.S.
Oil percentage	42.55	42.61	42.63	N.S.	42.59	42.60	42.61	N.S.

A. Effect of Potassium:

Results showed that there were significant differences among means of potassium levels for upper number of capsules/plant, number of seeds/capsule, number of seeds/plant and seed yield per plant as well as per faddan while, the differences on each of upper branching zone length, seed index and oil percentage did not reach the level of significance. Moreover, there were gradual increment towards the highest potassium level (48 kg. K_2O/fad.) in all seed characters. It could be reported that the application of potassium encouraged the physiological reactions to produce more seed components. This trend was in connection with that obtained by Hella et al. (1988), Dixited and Sharma (1993) and El-Sweify and Mostafa (1996).

B. Effect of nitrogen:

Analysis of variance indicated a significant increase on upper branching zone length, number of capsules/plant, number of seeds/capsules, number of seeds/plant and seed yield per plant as well as per faddan with increasing nitrogen levels up to 70 kg per faddan. On the other side, the increases in seed index and oil percentage did not reach the level of significance. The results clearly indicated that the application of 70 kg. nitrogen per faddan gave the highest mean values of seed yield and its related characters in comparison with the other nitrogen fertilizer levels. These results suggest that the high rates of nitrogen fertilizer prolongate the vegetative period which reflected on flax seed yield and its components, specially in sandy soil types. These findings agree with the results obtained by El-Ganyni et al. (1985), Salwa and El-Farouk (1991), El-Shimy et al. (1993), Jain et al. (1995) and Nada (1995).

C. Effect of the intercation:

Potassium x Nitrogen levels interaction had a significant effect on upper branching zone length, number of capsules/plant, number of seeds/plant, seed yield/plant as well as per faddan as shown in Table (5). This indicates that the two factors under study (potassium and nitrogen levels) were not similar in their effect on these characters.

Anatomical studies:

Estimation of different stem tissue areas and fiber index of flax stem at the middle region as affected by potassium and nitrogen levels are presented in Table (6).

Table 5. Effect of combination of potassium and nitrogen fertilizer levels on seed yield and its related characters (Average of 1994/1995 and 1995/1996 seasons).

Treatments	A_1			A_2			A_3			L.S.D.
Characters	B_1	B_2	B_3	B_1	B_2	B_3	B_1	B_2	B_3	
Upp. branching zone length (cm)	15.40	13.70	11.90	15.00	13.80	13.60	12.40	14.50	15.10	2.080
No. of capsules / plant	15.88	14.48	13.75	16.65	15.00	14.83	15.60	15.90	16.01	2.850
No. of seeds / capsules	7.93	8.08	8.23	8.30	8.45	8.60	8.90	9.05	9.12	N.S.
No. of seeds / plant	108.85	117.00	122.50	130.25	138.50	145.60	155.30	163.80	174.30	18.500
Seed yield / plant	1.11	1.13	1.15	1.19	1.21	1.23	1.31	1.35	1.41	0.280
Seed yield / fad. (kg.)	375.58	387.78	395.60	379.45	391.65	399.48	385.50	397.70	405.53	16.300
Seed index (g)	8.53	8.53	8.54	8.55	8.56	8.58	8.58	8.59	8.59	N.S.
Oil percentage	42.54	42.55	42.57	42.59	42.61	42.62	42.63	42.63	42.64	N.S.

A_1 : 24 Kg. K_2O / fed
A_2 : 36 Kg. K_2O / fed
A_3 : 48 Kg. K_2O / fed

B_1 : 50 Kg. N / fed
B_2 : 60 Kg. N / fed
B_3 : 70 Kg. N / fed

Regarding potassium fertilizer levels effect on the tissue areas of flax stems, it could be noticed that the highest potassium fertilizer rates (48 kg./fad.) produced the hgihest measurements of total cross section (112.90 mm^2), cortex area (21.80 mm^2), fiber area (9.20 mm^2), xylem area (44.10 mm^2), fiber bundle area (0.67 mm^2), and fiber index (0.778 mm^2). On the other hand, potassium level at the rate of 24 kg./fad. gave the highest pith area (39.07 mm^2).

Concerning the nitrogen fertilizer levels at the rates of 50, 60 and 70 kg./fad., data indicated that the highest nitrogen fertilizer level (70 kg./fad.) gave the highest values of the different tissue areas compared with the other rates, i.e. 50 and 60 Kg. /fad. in the all anatomical characters under study, except pith area character. On the other hand, nitrogen fertilizer rate of 50 kg./fad. gave the highest value for the pith area.

Table 6. Mean values of different stem tissues area and fiber index of flax stem as affected by potassium and nitrogen levels.

Treatments		K. Levels			N. levels		
Characters		24	36	48	50	60	70
Total cross section	(mm^2)	105.15	110.50	112.90	106.77	111.00	121.29
Cortex area	(mm^2)	21.46	21.53	21.80	19.96	24.65	25.30
Fiber area	(mm^2)	8.18	8.60	9.20	9.23	9.86	10.85
Xylem area	(mm^2)	40.70	40.93	44.10	36.80	44.45	48.90
Pith area	(mm^2)	39.07	39.00	36.07	40.24	32.90	30.39
Fiber bundle area	(mm^2)	0.51	0.59	0.67	0.44	0.58	0.64
Fiber index	(mm^3)	0.640	0.692	0.778	0.708	0.794	0.933

Stem tissue area percentage per cross section:

Estimation of different stem stem tissue areas as a percentage of the corresponding total cross section area as affected by potassium and nitrogen fertilizer levels are presented in Table (7).

For potassium fertilizer effect, data showed that the application of 48 Kg K2O/fad. produced the higherst percentages fo cortex % (22.18%), fiber % (8.15 %), xylem % (39.06%) and pith % (33.95%). The excess measurements as resulted by adding the highest potassium level when compared with the lowest dose 24 kg

K_2O/fad. were 1.77, 0.37, 0.36 and 0.84 for cortex %, fiber %, xylem and pith area percentages, respectively.

With regard to nitrogen fertilizer levels effect, data indicated that application of 70 kg.N/fad. produced the highest values for the all characters, cortex %, fiber %, xylem % and pith %.

Microscopic studies and fiber index:

Number of fiber bundles, number of fiber cells/bundle and fiber cell area (mm^2) as affected by potassium and nitrogen fertilizer levels are presented in Table (8).

Table 7. Estimates of the percentages for different tissue area of the corresponding total cross section (C.S.) of flax stem as affected by potassium and nitrogen levels.

Treatments	K. Levels			N. levels		
Characters	24	36	48	50	60	70
Cortex / C.S. %	20.41	19.73	22.18	20.63	22.21	20.86
Fiber / C.S. %	7.78	7.78	8.15	7.87	8.11	8.12
Xylem / C.S. %	38.70	37.04	39.06	38.03	40.05	43.84
Pith / C.S. %	33.11	33.61	33.95	23.18	29.63	33.47

Data obtained indicated that application of 48 kg. K_2O/fad. caused higher No. of fiber bundles, No. of fiber cells/bundle and fiber cell area than the lowest potassium rates at 24 kg. K_2O/fad. or 36 kg. K_2O/fad.

Concerning nitrogen fertilizer levels effect, results showed that the highest nitrogen rate 70 kg.N./fad. produced the highest estimates of No.of fiber bundles (22.50), No. of fiber cells/bundle (20.40) and fiber cell area (0.044 mm^2). In comparison with the minimum N. level at 50 kg. /fad. which reduced 12.00, 14.50 and 0.022 for the same three above mentioned traits, respectively.

Generally, it must be mentioned that there was gradual increment in No. of fiber bundles, No. of fiber cells/bundle and fiber cell area aseither potassium or nitrogen level increased from the lowest dose towards the hgiher one for each. More-

over, the lowest fertilizer doses for the two elements under study caused fewest fiber cells area and consequently more fiber fineness estimates as previously mentioned in technological characters.

Table 8. Mean values of fiber bundles per cross section (C.S.), fiber cells per bundle and fiber cell area of flax stem as affected by potassium and nitrogen levels.

Treatments	K. Levels			N. levels		
Characters	**24**	**36**	**48**	**50**	**60**	**70**
No. of fiber bundle / C.S.	12.30	14.50	18.20	12.00	15.60	22.50
No. of Fiber cells / bundle	13.20	15.80	17.60	14.50	18.20	20.40
Fiber cell area (mm^2)	0.029	0.037	0.051	0.022	0.032	0.044

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أستجابة الكتان للتسميد البوتاسي والنيتروجيني تحت ظروف الأرض الرملية

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معهد بحوث المحاصيل الحقلية - مركز البحوث الزراعية.

تم إجراء هذه الدراسة بمحطة بحوث الإسماعيلية، حيث التربة رملية فقرة في العناصر الغذائية، بهدف معرفة تأثير كل من التسميد البوتاسي والنيتروجيني علي المحصول ومكوناته وبعض الصفات التكنولوجية لصنف الكتان جيزة ٧ خلال موسمي ١٩٩٤ / ١٩٩٥، ١٩٩٥ / ١٩٩٦. وكانت مستويات التسميد البوتاسي هي ٢٤، ٣٦ ، ٤٨ كجم بو٢أ/فدان، ومستويات التسميد النيتروجيني ٥٠ ، ٦٠، ٧٠ كجم ن /فدان.

١ - إزداد محصول القش، وصفاته المرتبطة زيادة معنوية وملحوظة معنوية و ملحوظة بزيادة معدلات بزيادة معدلات التسميد البوتاسي من ٢٤ إلي ٤٨ كجم بو٢أ/فدان، وأعطت الزيادة في معدلات التسميد النيتروجيني نفس الإتجاه بالنسبة لمحصول القش، وصفاته المرتبطة فيما عدا صفة نعومة الألياف، حيث حدث بها نقص معنوي بزيادة معدلات النيتروجين من ٥٠ إلي ٧٠ كجم ن / فدان.

٢. كان هناك زيادة معنوية بزيادة مستويات التسميد البوتاسي في كل من عدد الكبسولات/نبات، عدد البذور/كبسولة، عدد البذور/نبات، محصول البذور/نبات، ومحصول البذور/فدان. ومن ناحية أخري، أدت زيادة مستويات التسميد النيتروجيني إلي زيادة معنوية في محصول محصول البذور وصفاته المرتبطة فيماعدا صفتي دليل البذرة والنسبة المئوية للزيت بالبذور.

٣. أظهر التفاعل بين مستويات التسميد البوتاسي والنيتروجيني معنوية فيما يختص بمحصول القش وصفاته المرتبطة، وكذلك محصول البذور وصفاته المرتبطة فيما عدا عدد البذور / كبسولة، دليل البذورة، والنسبة المئوية للزيت بالبذور.

٤. أعطي أعي معدل تسميد بوتاسي (٤٨ كجم/فدان)، وأعلي معدل تسميد نيتروجيني (٧٠ كجم/فدان) أكبر قيم في المساحة الكلية للقطاع، مساحة القشرة، مساحة الألياف، مساحة الخشب، ومساحة الحزم الليفة، النسبة المئوية للقشرة/قطاع عرضي، النسبة المئوية للألياف/قطاع عرضي، والنسبة المئوية للخشب /قطاع عرضي، والنسبة المئوية للنخاع/قطاع عرضي، وعدد الحزم الليفة، وعدد الخلايا الليفية، ومساحة الخلية.

٥. أعطي معدل التسميد البوتاسي (٢٤ كجم/فدان)، ومعدل التسميد الأزوتي ٥٠ كجم / فدان أكبر قيم في صفة مساحة النخاع.