ORGANIC MANUURING, SULPHUR AND FOLIAR SPRAY EFFECTS ON FLAX UNDER SANDY SOIL CONDITIONS

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ABSTRACT

The present investigation was carried out at Qalapshoo Agriculture Research Station, Bilqas district, Dakahlia Governorate, Egypt, during the two growing seasons of 2004 /2005 and 2005 /2006 in sandy soil. Two field experiments were conducted to study the effect of farmyard manure (FYM) at rates of (16.7, 33.3 and 50 t/ha.), and elemental sulphur levels of (Zero, 238, 476 and 714 Kg/ha.) and foliar application treatments (control, Nofatrin, Cetrin and EM) on yield and its components and quality of flax variety (Sakha 2). ***The results obtained could be summarized as follows :***

Increasing farmyard manure (FYM) rates from 16.7 up to 50 t/ha. significantly increased technical stem length, seed yields per plant and per hectare in the first season, fruiting zone length, stem diameter and number of seeds / capsule in the second season. Straw yield/plant as well as per hectare and straw with capsules yield /ha., fiber yield /ha. fiber length, fiber percentage, fiber strength and fineness, number of capsules and seeds/plant, seed index and oil percentage in both seasons.

Increasing elemental sulphur level from Zero up to 714 Kg S/ha. significantly increased stem diameter in the second season only. Technical stem length, fruiting zone length, straw yield per plant and per hectare, straw with capsules yield/ha. fiber yield /ha., fiber length, fiber percentage, fiber strength and fineness, number of capsules and seeds/plant, number of seeds/capsule, seed index, seed yields per plant and per hectare and oil percentage in both seasons.

Nofatrin application significantly increased fiber yield /ha., fiber percentage and fiber strength and fineness. Cetrin application significantly increased stem diameter, straw yield per plant as well

as per hectare, straw with capsules yield /ha., number of capsules and seeds/plant, number of seeds/capsule, seed index, seed yields per plant and per hectare and oil percentage. EM spray significantly increased technical stem length in the first season only, fruiting zone length and fiber length in both seasons.

The interaction among the experimental factors had a significant effect on most characteristics under study, it could be concluded that the highest straw and seed yields were obtained at 50 t FYM /ha. with 714 Kg S/ha. plus spray and with Cetrin, whereas the highest fiber yield was achieved at 50 t FYM /ha. and 714 Kg S/ha. and spray with Nofatrin.

INTRODUCTION

Sandy soil is poor in organic matter and most other nutrients. Soil organic matter (SOM) is a fundamental and transient component of soil that controls many chemicals, physical and biological properties affecting soil productivity. It is primary source of energy for soil ecosystem, and a major source of some plant nutrients in agroecosystems. Banik *et al.* (1997) studied the residual effects of Farmyard manure (FYM) on winter crops. In pot experiment and they found that, yields of winter crops were highest on plots previously given 10 t FYM + 20 Kg N $ha.^{-1}$ El-Gazzar (1997) studied the effect of inorganic and organic N sources on flax seed crop production. He reported that 60 Kg fed^{-1} urea-N gave the highest dry matter followed by pigeon and poultry manures. However, application of either 45 Kg N or humus, farmyard manure, sugarbeet compost and clover straw gave the lowest yields, respectively. In another study showed that, seed, stalk and fiber yields were higher with 10 t farmyard manure, and 13.1 Kg P $ha.^{-1}$ (Badiyala *et al.*, 1998). (Puste *et al.* (1999) reported that, the highest yield was obtained with 75% NPK (100 % = 60 : 30 : 30 Kg N : P_2O_5 : K_2O $ha.^{-1}$ plus 10 t FYM). Talha (2003) studied application of sewage sludge, poultry manure and processed town refuse with or without (400 Kg $fed.^{-1}$) and gypsum (5 t $fed.^{-1}$), as conditioners on soil productivity. He reported that.

Keywords: Flax, Linseed, *Linum usitatissimum* L., fertilizer, farmyard manure, sulphur, foliar application, FYM, EM

the addition of biosolids with or without agrochemicals significantly increased the straw and seed yields and its components of flax crop. Sulphur was used in many studies for decreasing soil pH, decreasing soil born disease and increasing available nutrients. Concerning sulphur fertilizing, several workers investigated the effect of sulphur on flax yield and its attributes, Chaubey and Dwivedi (1995) and Hemant *et al.* (2000) reported that seed yield was increased at 30 Kg S $ha.^{-1}$ while Dubey *et al.* (1997) and Dubey *et al.* (2000) found that phosphorus and sulfur at 40 kg $ha.^{-1}$ significantly increased oil yield. Banerjee *et al.* (2001) found that, sulfur at 20 Kg $ha.^{-1}$ and potassium at 25 Kg $ha.^{-1}$ produced the maximum values of growth attributes, yield parameters, seed yield and 1000-seed weight. Kimeber *et al.* (2004) found that, the highest S level of 200 Kg fed^{-1} had the best effect on technical stem length, number of capsules/plant, number of seeds/plant, seed yield $fed.^{-1}$, fiber length and fiber fineness.

Furthermore, micronutrients are considered one of the important factors for plant nutrition to protect flax plant against adverse environmental conditions. Lu and Qu (1986) reported that fiber yield and quality were increased with Mn, Cu, Zn and B foliar spraying. Kineber *et al.* (1998) and Mostafa *et al.* (1998) reported that spraying flax plants with Zn, Cu, and Mn increased straw and fiber yields per feddan, fiber quality, seed yield and its related characteristics. El-Azzouni *et al.* (2003) and El-Gazzar and El-Kaddy (2000). In addition, plant growth promoting substances such as Nofatrin, Cetrin, Potassium and Ascopin has been known to play an important role to increase flax yield and its components. Swierczewska and Sztuder (2001), Hanafy *et al.* (2004) and Mostafa and El- Deeb (2003) used magnesium, Cotngin or Foliafeed C and Foliatreen (micronutrient) as a fertilizer in flax. Thus, the aim of the present study was to investigate the effect of Farmyard manure rates, elemental sulphur levels and some nutrients foliar application on the yield, yield components and quality of Sakha 2 flax variety under sandy soil condition.

MATERIALS AND METHODS

Field experiments were conducted during the two growing seasons of 2004 /2005 and 2005/2006 at Qalapshoo Agriculture Research Station, Bilqas district. Dakahlia governorate. The mechanical and some chemical analysis of the soils under study are presented in Table (1) :

Table (1) : Mechanical and some chemical analysis of the experimental field at the two successive seasons

The season	Sand %	Silt %	Clay %	Soil type	pH	Ec	Available nutrients (ppm)			Total N %
							N	P	K	
Season 1st	95.91	2.41	1.68	Sandy	7.7	1.4	4.90	4.80	78.0	0.028
Season 2 nd	93.76	3.86	2.38	Sandy	7.8	1.5	5.60	5.60	62.0	0.031

Mechanical analysis of the soil samples were performed according to the method of Black (1982). Soil chemical analysis were conducted according to Cottenie *et al.* (1982). The preceding crop was barley (Hordeum vulgare) in both seasons. The experiments were laid out in a split – split plot design with four replications. The main plots were randomly assigned to three farmyard manure rates, i.e. 16.7, 33.3 and 50 t ha.$^{-1}$, the sub – plots to the elemental sulphur levels of zero, 238, 476 and 714 Kg ha.$^{-1}$ and the sub – sub plots to the four foliar applications i.e. control, Nofatrin, Cetrin and EM.

1- Nofatrin { 5% Nitrogen, 5% Phosphorus (P_2O_5) , 0.15 % chelated Iron, 0.15% chelated zinc, 0.1 % chelated Manganese, 0.05% Boron and 0.02% Molybdate + Spreading agents} .
2- Cetrin { 2% Iron , 2% Zinc, 2% Manganese, 15 % Organic acid and 3% Spreading agents} .
3- Effective Micro-organisms (EM) { photosynthetic bacteria, lactic acid bacteria , yeasts and others mixture} .

Source : Vents of the Ministry of Agricultural for selling Bio-fertilizers and the fertils.

The concentration of the foliar fertilizer was 1.0 L/300 L water for Nofatrin, 1.0 L / 150 L water for Cetrin and 1.0 Cm^3 / 1l. water for (EM). The foliar application treatments were applied in three equal doses as foliar spray at 60, 75 and 90 days from sowing. Tween 20 was used as a wetting agent at 0.5%. Control plants were sprayed with water containing only the wetting agent. The plot area was 6 m^2 (2 x 3 m). Sakha 2 flax variety was planted in 5 and 8 November in the first and second seasons by manual broadcast at the rate of 143 Kg seeds $ha.^{-1}$ nitrogen was added to plots in the form of ammonium nitrate 33.5 % at the rate of 143 Kg N $ha.^{-1}$ on three equal doses the first at the first irrigation, the second at the second irrigation and the later at the third irrigation. Calcium superphosphate (15.5 P_2O_5) at the rate of 36 Kg P_2O_5 $ha.^{-1}$, potassium sulphate (48% K_2O) at the rate of 57 Kg K_2O $ha.^{-1}$ and elemental sulphur were added to the soil before planting.

The other agricultural practices were applied as usually done in the ordinary flax fields. At maturity, ten guarded plants were hand pulled at random from each sub- sub plot to be used in determining the yield components of flax. Flax yields for straw, seeds per hectare and quality were determined on the whole plot area basis .

Data collected included :

A- Straw yield and its components:

1- Technical stem length (cm.) ***2- Fruiting zone length (cm).***
3- Stem diameter (m.m.). ***4- Straw yield / plant (g).***
5- Straw yield per hectare (t). ***6- Straw with capsules yield per hectare (t).***

B- Fiber yield and its components :

1- Fiber yield per plant (g). ***2- Fiber yield / hectare (t).***
3- Fiber length (cm). ***4- Fiber percentage.***
5- Fiber strength (R. K. M.). **6- Fiber fineness (N.m.).**

Fiber fineness : In metrical number (N. m.) was determined by using Radwan and Momtaz methods (1966) according to the following formula :

$$N.m. = \frac{N \times L}{G}$$

Where : N.m. = metrical number
N = Number of fiber (20 fibers each 10 cm)
L = Length of fiber in (m.m.)
G = Weight of fiber in (mg)

III- Seed yield and its components :

1- Number of capsules /plant . ***2- Number of seeds / capsule.***
3- Number of seeds / plant. ***4- Seed index (g/1000-seed).***
5- Seed yield / plant (g). ***6- Seed yield / hectare (t) .***
7- Oil percentage.

All data were subjected to the analysis of variance according to the procedures outlined by Snedocor and Cochran (1980). The mean value of treatments were compared according to Duncan's Multiple Range Test (Duncan, 1955). All statistical analysis were performed using analysis of variance technique by means of MSTATC computer software package.

Results and Discussion

I- Straw yield and its components:

Analysis of variance show significant differences among the three Farmyard manure (FYM) rates in studied the six characteristics of straw yield except technical stem length in the second season and fruiting zone length and stem diameter in the first season did not reach the level of significance.

Results indicate that addition of 50 % FYM $ha.^{-1}$ ranked first and recorded maximum estimates of all characteristics studied in both seasons. Generally, the above treatments mentioned of flax crop surpassed the recommended rates of mineral fertilizers which emphasized the potential to maximize the cost of flax production. Generally, speaking the above mentioned findings shed light on the significant potential economical and environmental concern of recycling FYM by sandy soil bioremediation and application of agrochemicals with regard to the quality of flax plants compared to

Table (2) : Means of straw yield and its related characteristics of flax as affected by farm yard manure rates and sulphur levels with foliar application in 2004 / 2005 and 2005 /2006 seasons

Characteristics	Season	Farmyard manure (t/ha.) (Fy)				Sulphur levels (Kg / ha.) (S)					Foliar application (Fo)					Interactions			
		Sig.	16.7	33.3	50.0	Sig.	0	238	476	714	Sig.	without	Nofatrin	Cetrin	EM	Fy x S	Fy x Fo	S x Fo	Fy x S x Fo
Technical stem length (cm)	04/05	*	70.2 b	71.4 b	75.6 a	*	67.2 d	68.7 c	75.6 b	78.6 a	*	71.4 c	72.9 ab	72.0 bc	73.5 a	*	*	*	*
	05/06	N.S	71.4	78.0	82.5	*	65.7 b	70.8 b	79.2 ab	93.6 a	N.S	72.0	76.5	76.5	85.5	N.S	N.S	N.S	N.S
Fruiting zone length (cm)	04/05	N.S	11.2	11.2	11.4	*	10.6 b	11.2 a	11.4 a	11.6 a	*	10.8 c	11.0 bc	11.2 b	12.0 a	*	*	*	*
	05/06	*	14.2 b	14.2 b	15.4 a	*	14.2 c	14.4 bc	14.8 ab	15.2 a	*	14.0 c	15.0 ab	14.6 b	15.2 a	*	*	*	*
Stem diameter (m m)	04/05	N.S	1.90	1.90	1.94	N.S	1.90	1.92	1.92	1.92	*	1.84 c	1.92 b	1.98 a	1.92 b	N.S	N.S	*	*
	05/06	*	1.92b	1.96 b	2.08 a	*	1.92 b	1.94 b	1.98 ab	2.12 a	*	1.90 c	1.92 bc	2.02 a	2.01 a	*	*	*	*
Straw yield plant (g)	04/05	*	0.45 c	0.54 b	0.57 a	*	0.45 c	0.48 b	0.57 a	0.57 a	*	0.48 c	0.51 b	0.54 a	0.54 a	*	*	*	*
	05/06	*	0.66 b	0.69 b	0.81 a	*	0.63 c	0.69 b	0.69 b	0.87 a	*	0.66 c	0.72 b	0.78 a	0.72 b	*	*	*	*
Straw yield hectare (t)	04/05	*	5.857 c	6.100 b	6.343 a	*	5.136 c	6.043 b	6.179 b	7.043 a	*	5.757c	6.157 b	6.421 a	6.064 b	*	*	*	*
	05/06	*	7.043 c	7.286 b	7.793 a	*	6.171 c	7.736 b	7.757 ab	7.829 a	*	6.536d	7.536 b	8.050 a	7.371 c	*	*	*	*
Straw with capsules yield hectare (t)	04/05	*	11.043 c	11.186 b	12.172 a	*	10.764b	11.272c	11.836 b	11.993 a	*	10.886d	11.614 b	11.822 a	11.543c	*	*	*	*
	05/06	*	13.086 c	14.107 b	14.879 a	*	11.979c	14.264b	14.836 a	15.014 a	*	13.079c	13.957 b	15.107 a	13.943 b	*	*	*	*

**** and N.S. indicate P < 0.05, P < 0.01 and not significant, respectively.***

Means designated by the same letters are not significantly different at the 5% level, according to Duncan's multiple range test.

mineral fertilizers. These results are in accordance with those obtained by Badiyala *et al.* (1998).

Concerning the effect of elemental sulphur, it is clear from the results in Table (2) that, the maximum mean values of straw yield and its components were obtained by increasing sulphur levels from zero up to 714 Kg ha.$^{-1}$ as compared with the control except stem diameter in the first season which did not reach the level of significant. Addition of elemental sulphur to soil may be led to increase micronutrients availability decreasing soil pH and therefore increase plant uptake of these nutrients and / or affect soil born disease and amendment the oxidation – reduction status with FYM. These results are in agreement with those reported by Hemant *et al.* (2000) and Kineber *et al.* (2004). Regarding foliar application effect, it is clear from results in Table (2) that, there was a significant effect in straw yield and its components in all studied traits except technical stem length did not reach the level of significant in the second season. It is clear that cetrin application gave the highest value in stem diameter, straw yield per plant and per hectare and straw with capsules yield/ha. in both seasons. There were no significant differences in stem diameter in the second season and straw yield/plant in the first season between Cetrin and EM. However, EM application gave the highest value in technical stem length and stem diameter in both seasons. This may be due to the high concentration of micronutrients in Cetrin. Also, EM may be contain some microbial extracts which made as plant growth regulators. These results are in harmony with those obtained by El-Gazzar and El-Kady (2000).

A summary of the significant interaction effects is given in Table (3). In this Table, The highest values of the interaction for the studied characteristics are given. Technical stem length in the first season, fruiting zone length, stem diameter , straw yield /plant, straw yield/hectare and straw with capsules yield/hectare in both seasons, represent the sequence in order of the planting pantries (Farmyard manure rate x sulphure levels x foliar application). It is clear that the highest values of technical stem length and fruiting zone length were recorded by 50 t FYM ha.$^{-1}$ and 714 Kg S ha^{-1} with Cetrin spray (F_{y_3} x S_4 X F_{o_4}). Also, the highest stem

Table (3) : Treatments that led to highest values of straw yield and its components in 2004 / 2005 and 2005 /2006 seasons

Characteristics	Seasons	Fy x S		Fy x Fo		S x Fo		Fy x S x Fo	
		Highest values	Treatment	Highest values	Treatment	Highest values	Treatment	Highest values	Treatment
Technical stem length (cm)	2004 05	82.5	$Fy_3 \times S_4$	79.2	$Fy_3 \times So_4$	85.8	$S_4 \times Fo_4$	89.4	$Fy_3 \times S_4 \times Fo_4$
	2005 06	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S
Fruiting zone length (cm)	2004/05	12.6	$Fy_3 \times S_4$	13.2	$Fy_3 \times So_4$	12.6	$S_4 \times Fo_4$	16.4	$Fy_3 \times S_4 \times Fo_4$
	2005/06	17.8	$Fy_3 \times S_4$	16.8	$Fy_3 \times So_4$	16.4	$S_4 \times Fo_4$	16.8	$Fy_3 \times S_4 \times Fo_4$
Stem diameter (m.m,)	2004/05	N.S	N.S	N.S	N.S	2.06	$S_4 \times Fo_3$	2.10	$Fy_3 \times S_4 \times Fo_3$
	2005/06	2.44	$Fy_3 \times S_4$	2.24	$Fy_3 \times Fo_3$	2.32	$S_4 \times Fo_3$	2.90	$Fy_3 \times S_4 \times Fo_3$
Straw yield / plant (g)	2004/05	0.75	$Fy_3 \times S_4$	0.66	$Fy_3 \times Fo_3$	0.63	$S_4 \times Fo_3$	0.76	$Fy_3 \times S_4 \times Fo_3$
	2005/06	1.08	$Fy_3 \times S_4$	0.90	$Fy_3 \times Fo_3$	0.96	$S_4 \times Fo_3$	1.32	$Fy_3 \times S_4 \times Fo_3$
Straw yield /hectare (t)	2004/05	8.382	$Fy_3 \times S_4$	6.840	$Fy_3 \times Fo_3$	7.483	$S_4 \times Fo_3$	9.839	$Fy_3 \times S_4 \times Fo_3$
	2005/06	9.353	$Fy_3 \times S_4$	8.489	$Fy_3 \times Fo_3$	9.332	$S_4 \times Fo_3$	12.116	$Fy_3 \times S_4 \times Fo_3$
Straw with capsules yield /ha.	2004/05	13.802	$Fy_3 \times S_4$	13.852	$Fy_3 \times Fo_3$	13.616	$S_4 \times Fo_3$	16.786	$Fy_3 \times S_4 \times Fo_3$
	2005/06	16.300	$Fy_3 \times S_4$	17.065	$Fy_3 \times Fo_3$	17.307	$S_4 \times Fo_3$	20.513	$Fy_3 \times S_4 \times Fo_3$

Where : N.S. = Not significant Fy_3 = 50 t FYM/ha. S_4 = 714 Kg S/ha. Fo_3 = Cetrin Fo_4 = EM

diameter, straw yield per plant and per hectare and straw with capsules yield ha.$^{-1}$ were obtained at 50 t FYM ha.$^{-1}$ and 714 Kg S ha.$^{-1}$ with Nofatrin spray (Fy_3 x S_4 X Fo_3) and significantly affected by the interactions (Fy x S), (Fy x Fo) and (S x Fo) in both seasons except stem diameter in the first season for (Fy x S) and (Fy x Fo) interactions. These results agree with those of Chaubey and Dwivedi (1995).

B- Fiber yield and its components:

Statistical analysis revealed significant differences among the three Farmyard manure rates in all fiber characteristics except fiber yield / plant did not reached the level of significance in both seasons. Data in Table (4) illustrated that adding 50 t FYM ha.$^{-1}$ gave the highest values of fiber yield ha.$^{-1}$, fiber length, fiber percentage, fiber strength and fiber fineness compared with the other in both seasons. This may be due to the amount of the nutrients available for the plants increased with the high level of FYM by mineralization of the organic materials in addition to some organ acids from FYM degradation and amino acids which enhance plant growth and fiber amounts and length. Similar results were also obtained by Talha (2003).

Respecting the effect of elemental sulphur levels were significant differences in all fiber characteristics were obtained except for fiber yield / plant, did not reach the leveled of significance in both seasons. Data show that in Table (4) increasing sulphur levels from zero up to 714 kg ha.$^{-1}$ caused an increase in fiber yield ha.$^{-1}$, fiber length, fiber percentage, fiber strength and fiber fineness. This may be due to that the presence of sulphur enhance flax growth by decreasing the soluble salts at the root zone, decreasing the soil pH which led to increase some nutrients availability i.e. phosphorus and micronutrients and role of sulphur in the plant as macronutrients and oxidation- reduction potential in the soil and plants. Similar findings. were reported by Hemant *et al.* (2000) and Kineber *et al.* (2004).

Generally, foliar application effect is clear from the results in Table (4) which indicated that , there was a significant effect on fiber yield and its components in all studied parameters except fiber yield / plant in both seasons and fiber length in the first season. It

Table (4) : Means of fiber yield and its related characteristics of flax as affected by farm yard manure rates and sulphur levels with foliar application in 2004 / 2005 and 2005 /2006 seasons

Character-istics	Season	Farmyard manure (t/ha.) (Fy)				Sulphur levels (Kg / ha.) (S)					Foliar application (Fo)					Interactions			
		Sig.	16.7	33.3	50.0	Sig.	0	238	476	714	Sig.	Without	Nofatrin	Cetrin	EM	Fy x S	Fy x Fo	S x Fo	Fy x Sx Fo
Fiber yield / plant (g)	04/05	N.S	0.07	0.08	0.09	N.S	0.07	0.08	0.08	0.09	N.S	0.07	0.09	0.08	0.08	N.S	N.S	N.S	N.S
	05/06	N.S	0.10	0.11	0.12	N.S	0.10	0.11	0.11	0.12	N.S	0.10	0.12	0.11	0.11	N.S	N.S	N.S	N.S
Fiber yield / hectare (t)	04/05	**	0.926 c	0.977 b	1.042 a	**	0.765 d	0.958 c	0.985 b	1.217 a	**	0.858 d	1.070 a	1.026 b	0.971 c	*	*	*	*
	05/06	**	1.197 c	1.333 b	1.480 a	**	1.057 d	1.372 c	1.409 b	1.509 a	**	1.108 d	1.471 a	1.437 b	1.331 c	*	*	*	*
Fiber length (cm)	04/05	*	68.0 c	69.2 b	73.4 a	**	65.0 d	66.5 c	73.4 b	76.4 a	N.S	69.2	70.7	70.0	71.1	*	N.S	N.S	*
	05/06	*	69.2 c	75.8 b	80.3 a	**	63.5 d	68.6 c	77.0 b	91.4 a	*	70.0 c	74.3 b	74.3 b	83.3 a	*	*	*	*
Fiber percentage	04/05	*	16.0 c	16.2 b	16.6 a	**	15.2 c	16.1 b	16.2 b	17.5 a	**	15.1 c	17.4 a	16.3 b	16.2 b	*	*	*	*
	05/06	*	17.0 c	18.3 b	19.0 a	**	17.3 c	18.0 b	18.3 b	19.4 a	**	17.1 c	19.2 a	18.4 b	18.3 b	*	*	*	*
Fiber strength (R. K. M.)	04/05	**	68.2 c	70.4 b	72.3 a	**	67.6 d	69.8 b	71.3 b	72.5 a	**	68.2 c	72.7 a	69.7 b	70.7 b	*	*	*	*
	05/06	**	73.3 c	75.3 b	77.4 a	**	72.4 d	74.5 c	76.6 b	77.7 a	**	73.5 d	77.6 a	74.5 c	75.6 b	*	*	*	*
Fiber fineness (N.m.)	04/05	**	314.2 c	325.2 b	333.1 a	**	311.6 d	319.4 c	326.2 b	339.5 a	**	310.5 c	340.9 a	321.7 b	323.7 b	*	*	*	*
	05/06	**	390.1 c	401.2 b	410.3 a	**	373.7 d	391.6 c	412.4 b	424.2 a	**	370.5 c	425.7 a	400.9 b	404.7 b	*	*	*	*

**, ** and N.S. indicate P < 0.05, P < 0.01 and not significant, respectively.*

Means designated by the same letters are not significantly different at the 5% level, according to Duncan's multiple range test.

Table (5) : Treatments that led to highest values of fiber yield and its components in 2004 / 2005 and 2005 /2006 seasons

Characteristics	Seasons	Fy x S		Fy x Fo		S x Fo		Fy x S x Fo	
		Highest values	Treatment	Highest values	Treatment	Highest values	Treatment	Highest values	Treatment
Fiber yield / ha. (t)	2004/05	1.187	$Fy_3 \times S_4$	1.287	$Fy_3 \times Fo_2$	1.320	$S_4 \times Fo_2$	1.387	$Fy_3 \times S_4 \times Fo_2$
	2005/06	1.687	$Fy_3 \times S_4$	1.590	$Fy_3 \times Fo_2$	1.510	$S_4 \times Fo_2$	1.720	$Fy_3 \times S_4 \times Fo_2$
Fiber length (cm)	2004/05	83.7	$Fy_3 \times S_4$	N.S	N.S	N.S	N.S	87.1	$Fy_3 \times S_4 \times Fo_4$
	2005/06	94.9	$Fy_3 \times S_4$	91.5	$Fy_3 \times Fo_4$	90.8	$S_4 \times Fo_4$	104.2	$Fy_3 \times S_4 \times Fo_4$
Fiber percentage	2004/05	18.9	$Fy_3 \times S_4$	18.0	$Fy_3 \times Fo_2$	17.5	$S_4 \times Fo_2$	19.9	$Fy_3 \times S_4 \times Fo_2$
	2005/06	12.8	$Fy_3 \times S_4$	20.0	$Fy_3 \times Fo_2$	19.0	$S_4 \times Fo_2$	22.1	$Fy_3 \times S_4 \times Fo_2$
Fiber strength (R. K. M.)	2004/05	82.4	$Fy_3 \times S_4$	80.2	$Fy_3 \times Fo_2$	79.0	$S_4 \times Fo_2$	82.8	$Fy_3 \times S_4 \times Fo_2$
	2005/06	88.2	$Fy_3 \times S_4$	86.0	$Fy_3 \times Fo_2$	85.0	$S_4 \times Fo_2$	88.6	$Fy_3 \times S_4 \times Fo_2$
Fiber fineness (N.m.)	2004/05	386.4	$Fy_3 \times S_4$	380.0	$Fy_3 \times Fo_2$	379.0	$S_4 \times Fo_2$	388.6	$Fy_3 \times S_4 \times Fo_2$
	2005/06	483.3	$Fy_3 \times S_4$	478.1	$Fy_3 \times Fo_2$	469.0	$S_4 \times Fo_2$	485.3	$Fy_3 \times S_4 \times Fo_2$

Where : N.S. = Not significant Fy_3 = 50 t FYM/ha. S_4 = 714 Kg S/ha. Fo_1 = Cetrien Fo_2 = Nofatrin

must be concluded that Nofatrin application recorded superiority in fiber yield characteristics when compared with the control. Moreover, Nofatrin traits gave the highest values for fiber yield ha.$^{-1}$, fiber percentage and fiber strength and fineness in both seasons. While, EM trait gave the highest value in fiber length in the first season and did not reach the level of significance in the second season. There were no significant differences among Cetrin and EM in fiber percentage, fiber strength and fiber fineness in both seasons. This may be due to that EM contain micro organisms that produce regulator materials enhance fiber length and fiber percentage. The present are in full agreement with those obtained by El-Gazzar and El-Kady (2000).

A summary of the significant interaction effects is given in Table (5). In this Table, the highest values of the interaction for the studied characteristics are given fiber yield /ha. , fiber length, fiber percentage, fiber strength and fiber fineness in both seasons . represent the sequence in order of the planting pantries (farmyard manure rates x sulphur x foliar application). It is clear that the highest values of fiber yield/plant, fiber percentage, fiber strength and fiber fineness were recorded by 50 t FYM /ha. and 714 Kg S/ha. with Nofatrin spray (Fy_3 x S_4 x Fo_2) and significantly affected by the interactions (Fy x S) , (Fy x Fo) and (S x Fo) in both seasons. Also, the highest fruiting zone length was obtained at 50 t FYM/ha. and 714 Kg S/ha. with EM spray (Fy3 x S4 x FO_4) and significantly affected by the interaction (Fy x S) in both seasons. While, the interactions (Fy x F0) and (S x Fo) in the second season only. Similar findings were obtained by Chaubey and Dwivedi (1995).

C- Seed yield and its components :

Data presented in Table (6) clearly show that seed yield and its components were significantly affected by farmyard manure levels in all characteristics studied except number of seeds /capsules in the first season and seed yield per plant and per hectare in the second seasons. did not reach the level of significance, results showed that adding 50 t FYM /ha. gave the highest values in all characteristics under study in both seasons. This may be due to that the high level of farmyard manure increased favorable characteristics of the soil i.e., water holding capacity and available

Table (6) : Means of seed yield and its related characteristics of flax as affected by farmyard manure rates and sulphur levels with foliar application in 2004 / 2005 and 2005 /2006 seasons

Characteristics	Season	Farmyard manure (t/ha.) (Fy)				Sulphur levels (Kg / ha.) (S)					Foliar application (Fo)					Interaction			
		Sig.	16.7	33.3	50.0	Sig.	0	238	476	714	Sig.	Without	Nofatrin	Cetrin	EM	Fy x S	Fy x Fo	S x Fo	Fy x S x Fo
Number of capsules / plant	04/05	*	7.5 b	7.6 b	11.4 a	*	7.2 c	7.5 c	8.3 b	10.8 a	*	7.6 b	9.3 a	9.5 a	8.9 a	*	*	*	*
	05/06	*	9.6 b	10.8 ab	11.2 a	*	9.6 c	10.4 b	11.2 a	11.6 a	*	9.6 c	11.2 b	12.0 a	10.0 c	*	*	*	*
Number of seeds /capsule	04/05	N.S	4.4	4.4	4.7	*	3.8 c	4.4 b	4.7 ab	5.0 a	*	4.0 c	4.4 b	5.0 a	4.6 b	*	N.S	*	*
	05/06	*	5.7 c	5.9 b	6.2 a	*	5.2 d	5.6 c	6.0 b	7.0 a	*	5.7 b	5.8 b	6.5 a	5.8 b	*	*	*	*
Number of seeds / plant	04/05	*	32.4 c	35.2 b	44.8 a	*	28.0 c	36.8 b	42.4 a	42.8 a	*	34.0 c	37.6 b	41.6 a	36.8 b	*	*	*	*
	05/06	*	59.6 c	68.4 b	73.2 a	*	54.4 d	64.0 c	70.4 b	79.2 a	*	58.8 d	66.4 b	80.4 a	62.4 c	*	*	*	*
Seed index (g/1000-seed)	04/05	*	7.35 c	7.84 b	8.42 a	*	7.2 c	7.74 b	8.07 ab	8.46 a	*	7.62 c	7.95 ab	8.17 a	7.74 bc	*	*	*	*
	05/06	*	8.35 b	8.81 a	9.07 a	*	8.38 b	8.76 a	8.88 a	8.97 a	*	8.61 b	8.85 a	8.95 a	8.56 b	*	*	*	*
Seed yield / plant (g)	04/05	*	0.19 b	0.19 b	0.35 a	**	0.16 c	0.19 bc	0.25 b	0.38 a	N.S	0.19	0.25	0.31	0.22	N.S	N.S	*	N.S
	05/06	N.S	0.37	0.41	0.41	**	0.30 b	0.40 a	0.41 a	0.48 a	*	0.33 c	0.44	0.44 a	0.36 b	*	*	N.S	*
Seed yield hectare (t)	04/05	*	1.495 c	1.657 b	1.752 a	*	1.466 d	1.590 c	1.704 b	1.771 a	*	1.428 d	1.733 b	1.762 a	1.609 c	*	*	*	*
	05/06	N.S	2.143	2.157	2.293	**	1.921 d	1.943 c	2.278 b	2.650 a	**	1.843 d	2.236 b	2.521 a	2.195 c	*	N.S	*	*
Oil percentage	04/05	*	40.0 c	40.5 b	41.0 a	*	39.0 d	40.0 c	41.0 b	42.0 a	*	39.0 d	40.0 c	42.0 a	41.0 b	*	*	*	*
	05/06	*	40.5 c	41.0 b	41.5 a	*	39.0 d	40.5 c	41.5 b	43.0 a	*	39.5 d	40.5 c	42.5 a	41.5 b	*	*	*	*

**, ** and N.S. indicate P < 0.05, P < 0.01 and not significant, respectively.*

Means designated by the same letters are not significantly different at the 5% level, according to Duncan's multiple range test.

nutrients especially the studied soil was sandy in texture. This finding are in agreement with those obtained by Talha (2003).

Relatively the effects of the four different sulphure levels on seed yield and its characteristics is presented in Table (6). The results indicated that increased sulphur application from zero up to 714 Kg /ha. significantly increased number of capsules/plant. number pf seeds/ capsule. number of seeds/plant, seed index. seed yields per plant and per hectare and oil percentage in both seasons.

From the previous knowledge there are three amino acids needs sulphur in their stricter as well as oil need sulphur for complete formation. This finding agree with those obtained by Kiniber *et al.* (2004).

Concerning foliar application effect, data show significant differences in seed yield and its related characteristics in both seasons except seed yield /plant in the first season did not reach the level of significance, Table (6). Results indicated that Cetrin treatment ranked first and recorded maximum estimates of number of capsules / plant. seed index. seed yields per plant and per hectare and oil percentage in both seasons, without significant differences among Nofatrin, Cetrin and EM for number of capsules/plant in the first season and Nofatrin and Cetrin for seed index and seed yield/plant in the second seasons.

This may be due to foliar application for some nutrients help plants cultivated in the sandy soil to absorb micronutrients which produce healthy plants. These results are in partial agreement with those obtained by El-Gazzar and El-Kady (2000).

A summary of the significantly interaction effects among the three experimental factors is given in Table (7). In this Table he highest values of the studied characteristics are given. Number of capsules/plant, number of seeds/capsule, number of seeds/plant, seed index, seed yield/plant in second seasons, seed yield/hectare and oil percentage in both seasons, were affected significantly by the interaction (Fy x S x Fo). The highest values of them were achieved by 50 t FYM /ha. and 714 Kg S/ha. with Cetrin (Fy_3 x S_4 x Fo_3). The interaction (Fy x S) affected significantly all studied characteristics except seed yield/plant in first season. The highest values were achieved by 50 t FYM /ha. with 714 Kg S/ha. The

Table (7) : Treatments that led to highest values of seed yield and its components in 2004 / 2005 and 2005 /2006 seasons

Characteristics	Seasons	Fy x S		Fy x Fo		S x Fo		Fy x S x Fo	
		Highest values	Treatment	Highest values	Treatment	Highest values	Treatment	Highest values	Treatment
Number of capsules / plant	2004/05	15.8	$Fy_3 \times S_4$	13.3	$Fy_3 \times Fo_3$	13.5	$S_4 \times Fo_3$	19.0	$Fy_3 \times S_4 \times Fo_3$
	2005/06	14.0	$Fy_3 \times S_4$	14.8	$Fy_3 \times Fo_3$	13.2	$S_4 \times Fo_3$	19.6	$Fy_3 \times S_4 \times Fo_3$
Number of seeds /capsule	2004/05	5.5	$Fy_3 \times S_4$	N.S	N.S	7.1	$S_4 \times Fo_3$	7.5	$Fy_3 \times S_4 \times Fo_3$
	2005/06	9.3	$Fy_3 \times S_4$	7.0	$Fy_3 \times Fo_3$	8.1	$S_4 \times Fo_3$	9.5	$Fy_3 \times S_4 \times Fo_3$
Number of seeds / plant	2004/05	48.0	$Fy_3 \times S_4$	49.2	$Fy_3 \times Fo_3$	55.6	$S_4 \times Fo_3$	76.0	$Fy_3 \times S_4 \times Fo_3$
	2005/06	86.8	$Fy_3 \times S_4$	90.4	$Fy_3 \times Fo_3$	87.2	$S_4 \times Fo_3$	157.2	$Fy_3 \times S_4 \times Fo_3$
Seed index (g/1000-seed)	2004/05	9.4	$Fy_3 \times S_4$	8.6	$Fy_3 \times Fo_3$	8.8	$S_4 \times Fo_3$	10.0	$Fy_3 \times S_4 \times Fo_3$
	2005/06	9.3	$Fy_3 \times S_4$	9.7	$Fy_3 \times Fo_3$	9.8	$S_4 \times Fo_3$	11.2	$Fy_3 \times S_4 \times Fo_3$
Seed yield / plant (g)	2004/05	N.S	N.S	N.S	N.S	0.74	$S_4 \times Fo_3$	N.S	$Fy_3 \times S_4 \times Fo_3$
	2005/06	0.64	$Fy_3 \times S_4$	0.55	$Fy_3 \times Fo_3$	N.S	N.S	0.92	$Fy_3 \times S_4 \times Fo_3$
Seed yield /hectare (t)	2004/05	1.943	$Fy_3 \times S_4$	2.276	$Fy_3 \times Fo_3$	2.219	$S_4 \times Fo_3$	3.219	$Fy_3 \times S_4 \times Fo_3$
	2005/06	3.321	$Fy_3 \times S_4$	N.S	N.S	4.157	$S_4 \times Fo_3$	4.185	$Fy_3 \times S_4 \times Fo_3$
Oil percentage	2004/05	46.7	$Fy_3 \times S_4$	44.0	$Fy_3 \times Fo_3$	45.6	$S_4 \times Fo_3$	47.8	$Fy_3 \times S_4 \times Fo_3$
	2005/06	47.3	$Fy_3 \times S_4$	45.1	$Fy_3 \times Fo_3$	46.8	$S_4 \times Fo_3$	48.5	$Fy_3 \times S_4 \times Fo_3$

Where : N.S. = Not significant Fy_3 = 50 t FYM/ha. S_4 = 714 Kg S/ha. Fo_3 = Cetrien

interaction (Fy x Fo) affected significantly number of capsules/plant, number of seeds/plant, seed index and oil percentage in both seasons, number of seeds/capsule and seed yield/plant in the second season and seed yield/ha. in first season. The highest values were achieved by 50 t FYM/ha. with Cetrin (Fy_3 x Fo_3). The interaction (S x Fo) affected significantly characteristics under study in both seasons except seed yield / plant in the second season. The highest values were recorded by 714 Kg S/ha. plus Cetrin spray (S_4 x Fo_3). These results agree with those of Chaubey and Dwivedi (1995).

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الملخص العربى

تأثير السماد البلدى ومستويات الكبريت والتسميد بالرش على الكتان تحت ظروف الأراضى الرملية

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أجرى هذا البحث بمحطة البحوث الزراعية بقلابشو مركز بلقاس محافظة الدقهلية – خلال موسمى ٢٠٠٤ / ٢٠٠٥ و ٢٠٠٥ / ٢٠٠٦ بهدف دراسة إستجابة الكتان لمعدلات السماد البلدى وهى ١٦,٧ ، ٣٣,٣ ، ٥٠ طن / هكتار ومستويات من

الكبريت وهى (صفر ، ٢٣٨ ، ٤٧٦ ، ٧١٤ كجم كبريت / هكتار) والتسميد بالرش بالمواد الآتية : الرش بالماء و النوفترين و السترين والـــ EM (مواد محتوية على بكتريا) على محصول وجودة صنف الكتان سخا ٢ . ويمكن تلخيص النتائج المتحصل عليها فيما يلى :

أدت زيادة معدل السماد البلدى من ١٦,٧ إلى ٥٠ طن / هكتار إلى زيادة معنوية فى طول الساق الفعال ومحصول البذرة للنبات والهكتار فى الموسم الأول وطول المنطقة الثمرية وقطر الساق فى الموسم الثانى و محصول القش للنبات والهكتار ومحصول الهكتار من القش بالكبسول والألياف، طول الألياف ، النسبة المئوية للألياف، متانة ونعومة الألياف ، عدد كبسولات وبذور النبات ، وزن الألف بذرة والنسبة المئوية للزيت فى كلا الموسمين.

وكذلك أدت زيادة مستويات الكبريت من صفر إلى ٧١٤ كجم كبريت /هكتار إلى زيادة معنوية فى قطر الساق فى الموسم الثانى وطول الساق الفعال ، طول المنطقة الثمرية ، محصول القش للنبات والهكتار ومحصول القش بالكبسول والألياف للهكتار ، طول الألياف والنسبة المئوية للألياف، متانة الألياف ونعومتها، عدد كبسولات وبذور النبات ، عدد بذور الكبسولة ، وزن الألف بذرة ، محصول البذرة للنبات والهكتار والنسبة المئوية للزيت فى كلا الموسمين.

أما الرش بالنوفترين فقد أدى إلى زيادة معنوية فى محصول الألياف للهكتار والنسبة المئوية للألياف، متانة ونعومة الألياف. أدى الرش بالسترين إلى زيادة معنوية فى قطر الساق ، محصول القش للنبات والهكتار ، محصول الهكتار من القش بالكبسول ، عدد كبسولات وبذور النبات ، عدد بذور الكبسولة، وزن الألف بذرة ، محصول البذرة للنبات والهكتار والنسبة المئوية للزيت.

الرش بـ EM قد أدى إلى زيادة معنوية فى الطول الفعال للساق فى الموسم الأول ، طول المنطقة الثمرية وطول الألياف فى كلا الموسمين.

وقد كان للتفاعل بين عوامل الدراسة الثلاث تأثيرا معنويا على معظم الصفات المدروسة ومن نتائج البحث يمكن التوصية بزراعة صنف الكتان سخا ٢ وتسميده بمعدل ٥٠ طن من السماد البلدى / هكتار و ٧١٤ كجم كبريت / هكتار والرش بالسترين وذلك للحصول على أعلى محصول من القش والبذرة . بينما يمكن التوصية بالتسميد بنفس المعدلين السالف ذكرهما من السماد البلدى والكبريت مع الرش بالنوفترين للحصول على أعلى محصول من الألياف وذلك تحت ظروف منطقة قلابشو الرملية مركز بلقاس بمحافظة الدقهلية.