Australian Journal of Basic and Applied Sciences, 6(7): 532-536, 2012
ISSN 1991-8178

Effect of Fe Foliar Application on Yield and Quality Traits of Some Flax Varieties Grown Under Newly Reclaimed Sandy Soil

[1]Bakry, A.B., [1]Elewa, T.A. and [2]Ali, O.A.M.

[1]Field Crop Research Department, National Research Centre, Dokki, Cairo, Egypt
[2]Crop Science Department, Faculty of Agriculture, Minufiya University, Egypt

Abstract: Two field experiments were conducted at the Research and Production Station, National Research Centre, El-Nubaria Province, El-Behira Governorate, Egypt, during the two successive seasons of 2010/2011 and 2011/2012 to study the response of four flax varieties (Giza-8, Sakha-1, Sakha-2 and Agritic) to foliar application of four Fe levels (control, 1.0, 1.5 and 2.0 g/L) on seed, straw, oil and fiber yields as well as their components. Results revealed that Sakha-2 variety surpassed the other cultivars in seed yield, straw yield and oil yield. The superiority of seed yield/fed due to the increase in seed yield/ plant and 1000-seed weight, and the increase in fiber yield /fed due to the increase in straw yield /fed, and in oil yield due to the increase in seed yield/ fed. Also, results indicated that the highest seed yield/fed, straw yield/fed, oil yield /fed and fiber yield /fed were obtained by the foliar application of Fe at a rate of 2.0 g/L compared to the other levels and control treatment. The data cleared that the highest values for seed yield /fed, straw yield /fed, oil yield/fed and fiber yield /fed were obtained from the interaction between Sakha-2 variety and foliar application of Fe at a rate of 2.0 g/L compared to the other treatments.

Key words: Flax varieties, Fe foliar fertiliztion, quality traits.

INTRODUCTION

Flax (*Linum usitatissimum*, L.) is an annual plant which belongs to the family Linaceae. Flax is considered one of the most important dual purpose crops for oil and fiber production in Egypt and the world, Flax is rich in oil (41%), protein (20%), and dietary fiber (28%). Also, it has a high percentage of essential fatty acids which is an omega-3 fatty acid and linoleic acid, which is an omega-6 fatty acid (Morris, 2005), as well flax plays an important role in the national economy due to its importance in exportation and many local industrial purposes. It is an old economic crop which is used for the manufacture of linen. The oil is edible and also, due to its quick drying property, is used for the preparation of paints, varnishes, printing ink, oil cloth and soap.

Flax cultivars significantly differed in yield and its attributes (El-Shimy *et al*, 1993; Leilah, 1993; Sharief, 1993; El-Kady *et al.*, 1995 and Abo-Zaid, 1997). In this concern, Sharief (1999) reported that Liflora cultivar surpassed other four cultivars in plant height, technical length, 1000-seed weight and straw yield. However, Corse cultivar exceeded the others in stem diameter, number of fruiting branches/ plant, number of capsules/ plant as well as seed and oil yields/ fed. Meanwhile, Atlanta cultivar overcame the others in number of basal branches/plant.

Many investigators reported significant differences among flax varieties concerning seed, straw, oil and fiber yields and their components, El-Hariri, *et al*., (1998 and 2004).

It is well known, that the productivity of flax plants could be sustained through nutrition. Iron (Fe) is an essential element for plant growth. It is required for the formation of chlorophyll, the green pigments that capture light to produce food for the plant. Iron is also necessary for the proper functioning of many plant enzyme systems that influence respiration and plant metabolism and helps oxidize sugar for energy. The use of Fe foliar feeding for increasing flax production. Iron deficit often occurs when the soil pH is higher than 7.5 meaning it is more alkaline. Lack of Fe is common in plants living next to concrete walls, foundations etc. Iron deficiencies are mainly found on sandy soils low in organic matter. The effect of micronutrient elements on yield and crop performance has been reported by many investigators (Nasiri *et al.*, 2010) which mentioned that Fe enters many plant enzymes that play dominant roles in oxidoredox reactions of photosynthesis and respiration, Moreover, Marschner (1995) stated that micronutrients, especially Fe and Zn, act either as metal components of various enzymes or as functional, structural, or regulatory cofactors. Thus, they are associated with saccharide metabolism, photosynthesis, nucleic acid, lipid metabolism, and protein synthesis.

Therefore, the objective of this investigation was planned to study the response of four flax varieties to iron levels as foliar application under the environmental conditions of Nubaria district, in attempt to find a way to increase their productivity and technological parameters.

Corresponding Author: Bakry, A.B., Field Crop Research Department, National Research Centre, Dokki, Cairo, Egypt.
E-mail: Bakry_ahmed2004@yahoo.com

MATERIALS AND METHODS

Two field experiments were conducted at the Research and Production Station, National Research Centre, El-Nubaria Province, El-Behira governorate, Egypt, during the two successive seasons of 2010/2011 and 2011/2012. The aim of this investigation was planned to study the response of four flax varieties to four iron (Fe- EDTA 12%) levels as foliar application. The experiment included sixteen treatments in each growing season which were the combination of four varieties and four Fe levels which are as follows:

(A)- Varieties:

1- Giza-8
2- Sakha-1
3- Sakha-2
4- Agritic

(B)- Fe levels:

1- Control (spraying with tap water).
2- 1.0 g/L
3- 1.5 g/L
4- 2.0 g/L

The spraying treatments were done twice at 45and 60days after sowing using 400 liter solutions/fed. The experimental plot size was 3.5 meters long and 3.0 meters width occupying an area of 10.5 m2. Each mineral fertilizers of NPK were added at the rates of 100% from that recommended by the Egyptian Ministry of Agriculture. Calcium superphosphate (15.5% P_2O_5) and potassium sulphate (48% as K_2O) were added during soil preparation at the rates of 31.00 and 24.00 kg/fed respectively, while nitrogen fertilizer in the form of ammonium nitrate (33.5% N) was added at the rate of 75 kg N/fed. into two equal doses. The seeds were sown on the last week of November in both seasons for all treatments. Seeding rate of 1500 seeds /m^2 were hand drilled in rows 20 cm apart. The experimental soil was analyzed according to the method described by Chapman and Pratt (1978). Soil texture was sandy and having the following characteristics: Sand (93.7%); pH (7.8); organic matter (0.65%); CaCo3 (1.30%); EC (0.50 mmhos/cm^2); total N (8.1 ppm), P (3.60 ppm) and K (23.5 ppm) as an average of the two growing seasons.

At full maturity stage, ten guarded plants were taken at random from each plot to estimate plant height (cm), technical stem length (cm), number of fruiting branches /plant, number of capsules /plant, 1000-seed weight (g.) and seed and straw yields/plant (g.). Seed and straw yields/fed were estimated from the central area of one square meter of each plot. Plants were harvested, tied and left to dry, capsules were removed carefully to determine straw yield and then converted to straw yield in ton/fed., Seeds were cleaned from straw and other residuals and weighed to the nearest gram and converted to record seed yield (kg/fed), and then straw retting was carried out at Tanta flax and oil company using warm water retting system under controlled condition (30 – 35 ºC).

Seed oil % was determined by Soxhlet extraction apparatus using petroleum ether (40-60º) according to the method described by A.O.A.C. (1975). Oil yield (kg/fed) was calculated by multiplying seed yield/fed by seed oil percentage. Fiber percentage was calculated according to the following formula:

$$\text{Fiber \%} = \frac{\text{Weight of total fiber (g.)}}{\text{Weight of straw after retting (g.)}} \times 100$$

However, fiber yield (kg/fed) was calculated by multiplying straw yield/fed by fiber percentage.

The experimental design was laid out in a split plot design with four replications. Flax varieties were arranged at random in the main plots, while Fe levels were assigned at random in the sub-plots. All data were statistically analyzed according to the technique of analysis of variance (ANOVA) for the split plot design as published by Gomez and Gomez (1984). All statistical analysis were performed using the facility of computer and Co-Stat program computer software package (version 6.4). The differences among the means of different treatments were tested using the Least Significant Differences (LSD) at probability 5%.

RESULTS AND DISCUSSION

1- Varietal Differences:

Data presented in Table (1) revealed that high significant differences among the flax varieties in all studied characters. Sakha 2 cultivar surpassed the other varieties in seed yield/fed, straw yield/fed and oil yield/fed. The superiority in seed yield /fed may be due to the increases in seed yield/plant and 1000-seed weight, the increase in fiber yield /fed may be due to the increase in straw yield/fed. Moreover, the superiority in oil yield/fed may be attributed to the increase in seed yield /fed. Such results are in agreement with these obtained by many investigators, El-Sweify *et al.,* (2003), Kineber *et al*., (2006), Abd El-Fatah (2007), Khalifa, *et al*., (2011) and El-Hariri *et al*., (2012).

However, Giza 8 variety significantly exceeded the other varieties in number of branches/plant, number of capsules/plant, straw yield /plant and seed oil content. Such results are in agreement with those obtained by El-Hariri, *et al.,* (1998) and (2004) and Sorour *et al*., (1992).

Regarding minimum values of flax characters under investigation, the same table showed that Agritic variety gave the lowest values of plant height, technical stem length, number of branches/plant, seed yield/ plant, straw yield/plant, 1000-seed weight and seed, straw, fiber and oil yields/fed, while Sakha 1 variety gave the lowest value of number of capsules/plant. These results indicated that the variability among tested flax varieties which may be expected due to the differences of these varieties in origin, growth habit and genetic constituent and the environmental conditions of investigated cultivars under newly reclaimed sandy soil of Nubaria district. Such results are in agreement with these obtained by many investigators such as El-Sweify *et al.,* (2003), Khalifa, *et al*., (2011) and El-Hariri *et al*., (2012).

Table 1: The effect of varieties on seed, straw, oil, fiber yields and there components (combined analysis of 2010/2011 and 2011/2012 seasons).

Characters	Varieties				LSD (0.05)
	Giza-8	Sakha-1	Sakha-2	Agritic	
Plant height (cm)	73.19	74.29	73.00	68.94	0.75
Technical stem length (cm)	53.86	56.75	53.60	46.62	0.87
Fruiting zone length (cm)	19.33	17.54	19.40	22.32	0.25
No. of branches/ plant	7.34	6.95	7.00	6.00	0.50
No. of capsules/ plant	22.79	18.79	20.83	20.56	1.18
Seed yield/ plant (g)	1.06	0.88	1.19	0.85	0.03
Straw yield/ plant (g)	4.07	2.87	3.10	2.45	0.14
1000 seed weight (g)	8.13	8.37	8.42	5.05	0.03
Seed yield (kg/fed)	521.99	523.06	555.60	487.72	0.32
Straw yield (ton/fed.)	2.515	2.521	2.719	2.296	0.10
Oil %	37.45	36.96	36.98	36.28	0.25
Oil yield (kg/fed)	195.79	193.83	205.94	177.20	1.14
Fiber %	13.42	13.55	13.56	13.72	0.08
Fiber yield (kg/fed)	338.29	342.80	370.17	315.95	0.93

2- *Effect of Fe Levels:*

Data presented in Table (2) showed that there were significant differences among foliar application of Fe treatments tested in all studied characters. Results indicated that the highest seed yield/fed, straw yield /fed, oil yield /fed and fiber yield/fed were obtained at the Fe treatment (2.0 g/L) compare to control treatment. This may be due to the highest values reported of plant height, technical stem length, number of fruiting branches/plant, number of capsules per plant, straw yield per plant, seed yield/plant, 1000-seed weight, oil seed percentage and fiber percentage. The superiority of Fe (2.0 g/L) treatment over the other treatments could be attributed to Fe acts as a catalyst chlorophyll formation Mengel and Kirkby, (1987) and Khalifa, *et al*.,(2011), and improves the photosynthesis processes, leading to more dry matter production. Many investigators found positive effect of micronutrients on flax plants, among them, Mourad *et al*., (1988), Mostafa *et al*., (1998), El-Gazzar and El–Kady (2000), Moawed (2001) and Mostafa and El–Deeb (2003).

The high level (2.0 g/L) of Fe significantly increased seed yield/fed by 24.05 %, straw yield /fed by 43.55%, oil yield/fed by 33.38% and fiber yield/fed by 52.62 % over the control. In this connection, Khalifa, *et al*., (2011) suggested that Fe foliar application can improve the seed and straw yields of flax varieties.

Table 2: The effect of iron foliar spray on seed, straw, oil, fiber yields and there components (combined analysis of 2010/2011 and 2011/2012 seasons).

Characters	Fe foliar application (g/L)				LSD (0.05)
	control	1.0	1.5	2.0	
Plant height (cm)	58.76	67.06	79.50	84.09	0.88
Technical length (cm)	42.88	46.21	57.33	64.42	0.86
Fruiting zone length (cm)	15.88	20.85	22.18	19.68	0.97
No. of branches/ plant	4.85	6.18	7.55	8.70	0.94
No. of capsules/ plant	14.63	20.42	22.81	25.12	0.97
Seed yield/ plant (g)	0.69	0.94	1.14	1.22	0.02
Straw yield/ plant (g)	2.18	2.84	3.40	4.07	0.17
1000 seed weight (g)	7.39	7.45	7.54	7.61	0.02
Seed yield (kg/fed)	462.08	512.37	540.71	573.21	1.03
Straw yield (ton/fed)	2.076	2.334	2.661	2.980	0.20
Oil %	35.36	36.80	37.49	38.01	0.22
Oil yield (kg/fed)	163.40	188.61	202.79	217.95	1.38
Fiber %	13.15	13.38	13.73	13.99	0.04
Fiber yield (kg/fed)	272.97	312.23	365.39	416.62	1.80

3- Effect of Interaction BetweenFlax Varieties and Fe Foliar Fertilization:

The results presented in Table (3) showed that all studied characters were significantly affected by the interaction between tested flax varieties and Fe treatments. From this Table, it is clear that the highest values for seed yield /fed, straw yield/fed, oil yield /fed and fiber yield /fed characteristics were obtained from the interaction between Sakha-2 variety and the foliar application of Fe at a rate of 2.0 g/L. This was due to the increased in number of branches/plant, number of capsules/ plant, seed yield/plant (g) and 1000-seed weight (g). Such results are in agreement with those obtained by Khalifa, *et al*., (2011).

Table 3: The effect of interaction between flax varieties and Fe levels on seed, straw, oil, fiber yields and their components (combined analysis of 2010/2011 and 2011/2012 seasons).

varieties	Fe levels (g/letter)	Plant height (cm)	Technical length (cm)	Fruiting zone length (cm)	No. of branches/ plant	No. of capsules/ plant	Seed yield/ plant (g)	Straw yield/ plant (g)	1000 seed weight (g)	Seed yield/fed (kg)	Straw yield/fed (ton)	Oil (%)	Oil yield/fed (kg)	Fiber (%)	Fiber yield/fed (kg)
Giza-8	control	62.50	45.50	17.00	5.25	15.50	0.75	2.75	7.97	470.50	2.125	36.13	169.99	13.10	278.38
	1.0	66.80	47.80	19.00	6.30	23.66	1.01	3.49	8.02	512.62	2.315	37.10	190.18	13.33	308.59
	1.5	79.13	58.83	20.30	8.30	25.33	1.17	4.43	8.23	537.50	2.620	37.90	203.71	13.50	353.70
	2.0	84.30	63.30	21.00	9.50	26.66	1.30	5.60	8.32	567.35	3.000	38.65	219.28	13.75	412.50
Sakha-1	control	60.00	44.50	15.50	5.50	13.00	0.65	2.55	8.25	450.70	2.080	35.05	157.97	13.20	274.56
	1.0	69.16	50.86	18.30	6.50	19.00	0.93	2.70	8.37	519.25	2.220	37.00	192.13	13.35	296.37
	1.5	78.08	60.42	17.66	7.00	21.17	0.95	3.00	8.40	552.10	2.735	37.75	208.42	13.76	376.34
	2.0	89.90	71.20	18.70	8.80	22.00	1.00	3.21	8.47	570.19	3.050	38.02	216.79	13.90	423.95
Sakha-2	control	57.50	41.50	16.00	4.00	14.00	0.70	1.90	8.35	496.81	2.150	35.10	174.38	13.05	280.57
	1.0	63.33	44.33	19.00	6.40	18.50	0.95	2.55	8.41	537.42	2.590	36.90	198.31	13.37	346.28
	1.5	85.33	63.25	22.08	8.58	23.50	1.52	3.48	8.44	568.12	2.915	37.65	213.90	13.77	401.40
	2.0	85.83	65.33	20.50	9.00	27.30	1.60	4.48	8.47	620.04	3.220	38.25	237.17	14.05	452.41
Agritic	control	55.00	40.00	15.00	4.66	16.00	0.65	1.50	4.97	430.31	1.950	35.15	151.25	13.25	258.37
	1.0	68.96	41.86	27.10	5.50	20.50	0.85	2.60	4.98	480.17	2.210	36.20	173.82	13.47	297.69
	1.5	75.46	46.80	28.66	6.33	21.25	0.92	2.70	5.10	505.13	2.375	36.65	185.13	13.90	330.12
	2.0	76.33	57.83	18.50	7.50	24.50	0.98	3.00	5.16	535.25	2.650	37.10	198.58	14.25	377.62
LSD (0.05)		1.92	1.85	2.12	2.06	2.13	0.05	0.37	0.05	2.26	0.11	0.48	3.03	0.10	2.04

REFERENCES

A.O.A.C., 1975. Association of Official Analytical Chemists. Official Methods of analysis 12th Ed. Washington, D.C., USA.

Abd El-Fatah, A.A.E., 2007. Comparative study on some flax cultivars. J. Agric. Sci. Mansoura Univ., 32(9): 7111-7119.

Abo Zaied, T.A., 1997. Comparative study of yield technological characters of some flax varieties. Ph. D. Thesis, Fac. of Agric. Mansoura Univ., Egypt.

Chapman, H.D. and R.F. Pratt, 1978. Methods analysis for soil, plant and water. Univ. of California Div. Agric. Sci., 16-38.

El-Gazzar, A.A.M. and E.A.F. El-Kady, 2000. Effect of nitrogen levels and foliar application with nofatrin, cirin, potassin and ascopin on growth and quality of flax. Alex. J. Agric. Res., 45(3): 67-80.

El-Hariri, D.M., A.B. Bakry, T.A. Elewa and O.M. Ibrahim, 2012. Evaluation of some flax (*Linum usitatissimum*, L.) varieties under newly reclaimed sandy soil conditions. International Journal of Academic Research, 4(1): 98-102.

El-Hariri, D.M., M.S. Hassanein and Amna H. El-Sweify, 2004. Evaluation of some flax genotypes, straw yield, yield components and technological characters, J. of Natural fibers, 1(2), Agric. Res., 75(3): 697-715.

El-Hariri, D.M., M.S. Hassanein and M.A. Ahmed, 1998. Proceedings of the hemp, flax and other best fibrous plants, production, technology and ecology, Symposium Institute of Natural Fibers, Poznan, Poland, pp: 20-26.

EL-Kady, E.F.A., S.E. Shafshak, F.L. Gab-Allah and M.E.A. Kineber, 1995. Effect of seeding rates on yield and its components for six promising flax genotypes under saline conditions. J. Agric. Sci. Mansoura Univ., 20(2): 593-602.

EL-Shimy, G.H., E.A. El-Kady and N.K.M. Mourad, 1993. Effect of seeding rates and nitrogen fertilizer levels on yield and anatomical manifestation on some flax genotypes. J. Agric. Res. Tanta. Univ., 19(1): 92-104.

El-Sweify, H.H. Amna, M.A. Tag El-Din and H.A.M. Sharaf El-Deen, 2003. Effect of some flax genotypes and harvesting dates on seed chemical composition, yield and fiber quality. Annals of Agric. Sci., Moshtohor, 41(1): 19-37.

Gomez, K.A. and A.A. Gomez, 1984. Statistical procedures in agricultural research, 2nd Ed. pp.180 John wily and sons, New York U.S.A.

Khalifa, R. Kh. M., F.M. Manal, A.B. Bakry and M.S. Zeidan, 2011. Response of some flax varieties to micronutrients foliar application under newly reclaimed sandy soil. Australian Journal of Basic and Applied Sciences, 5(8): 1328-1334.

Kineber, M.E.A., F.A. El-Emary and M.F. El-Nady, 2006. Botanical studies on some fibrous flax (*Linum usitatissimum*, L.) genotypes grown under Delta conditions. J. Agric. Sci., Mansoura Univ., 31(5): 2881-2890.

Leilah, A.A., 1993. Evaluation of yield and its components of flax cultivars under different nitrogen fertilizer levels. J. Agric. Sci. Mansoura Univ., 18(2): 313-321.

Marschner, H., 1995. Mineral nutrition of high plant. Academic Press, pp: 330-355.

Mengel, K. and A. Kirkby, 1987. Chapter 16 : Copper. In : “Principles of Plant Nutrition” 4th Ed., K. Mengel and A. Kirkby (Eds). International Potash Institute. Bern. Switzerland, 537-549.

Moawed, E.A., 2001. Effect of micronutrients and new distances on the yield of some flax (*Linum usitatissimum*, L.) varieties. Egypt. J. Applied Sci., 16: 157-172.

Morris, D., 2005. Flax- a health and nutrition primer. Flax Council of Canada. Availableat:http://www.flaxcouncil.ca/english/index.php?p=primer&mp=nutrition (Accessed February, 2008).

Mostafa, S.H. and E.I. El-Deeb, 2003. Response of flax and quality to seeding rates and micronutrients. Alex. J. Agric. Res., 24: 425-442.

Mostafa, S.H.A., M.E.A. Kineber and S.Z.Z. Zedan, 1998. Effect of phosphorus levels and some micronutrients on flax yield and quality. Egypt J. Agric. Res., 76(1): 163-173.

Mourad, N.K.M., A.M. Hella and S.M. Gaffer, 1988. Effect of different N, Zn and SO_4 levels and their combinations on yield and fiber quality of flax (*Linum usitatissimum* L.) Agric. Res. Rev., 66(3): 407-414.

Nasiri, Y., S. Zehtab-Salmasi, S. Nasrullahzadeh, N. Najafi and K. Ghassemi-Golezani, 2010. Effects of foliar application of micronutrients (Fe and Zn) on flower yield and essential oil of chamomile (*Matricaria chamomilla,* L.). J. Med. Plants Res., 4(17): 1733-1737.

Sharief, A.E., 1993. Response of some introduced and local flax cultivars to seeding rates. J. Agric. Sci. Mansoura Univ., 18(10): 2827-2834.

Sharief, A.E., 1999. Performance of some flax cultivars in response to nitrogen fertilizer rates and yield analysis. Bull. Fac. Agric. Cairo Univ., 50: 394-415.

Sorour, S.Gh.R., S.H. Abou- Khadrah, S.A. Yossef, E.A.F. El-Kady and A.A. El-Gazzar, 1992. Effect of planting pattern and seeding rate on growth yield and quality of some flax varieties. Proc 5th Conf. Agron. Zagazig, Egypt, 2: 836-850.