



Journal homepage: www.sciencearchives.org

ISSN: 2582-6697



Review Article

<http://dx.doi.org/10.47587/SA.2020.1302>



The role of different fertilization strategies on the yield and quality of different flax varieties in the new lands

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Received: Nov 13, 2020 / Revised: Dec 02, 2020/ Accepted: Dec 14, 2020

Abstract

This review aims to show the reason for planting the flax crop in the new lands by highlighting some varieties that were successfully cultivated in these lands and have achieved promising results. In addition to following up and evaluate their growth characters and yield. On the other hand, applying some fertilization strategies in these lands has demonstrated many varieties in their productive capacity among themselves according to soil conditions and production efficiency. The usage of different fertilizers whether biological, organic, or chemical show differences in their supply capacity for the crop with nutrients either macro or minor. It can be concluded from this review that our using of the most suitable varieties adapted to the conditions of the new lands within a framework of balanced fertilization, which is reflected in the physiological state and leading to the highest productivity and best quality.

Keywords Flax, Varieties, New Land, Fertilization, Yield, Quality

Introduction

Flax (*Linum usitatissimum* L.) crop is versatile, with both seeds and fiber uses including industrial, medical, and food such as textiles, paints, grain wood, edible oil, cosmetics ...etc. It occupies about 0.01% of the average value of agriculture income during the period from (2015-2017) and about 1.65% of the average value of fiber crops for the same period (Abd El- Fattah et al., 2020). In Egypt, the flax cultivated area is related limited and decreased dramatically in the last decade which reached about 11.14 thousand feddans for the same period. This reduction was due to strong competition between flax and other winter season crops on the limited arable land (Bakry, 2009), which led to the creation of a gap between production and consumption. To overcome this problem, we must work in three ways. One of that is by expanding its cultivation in the new lands (Nofal et al., 2011).

The secondary can go through using highly protective varieties than that seed under the recent cultivation (Shedeed et al., 2016). The third one is improving the fertilization treatments (El-Gazzar, 2006, Nofal and Rezk, 2009 and Abd El- Fattah et al., 2020). Therefore, this review is an attempt to highlight how the yield and quality of flax can be improved under new land conditions.

Materials and Methods

Effect of new lands characteristics

Many researchers conducted their experiments on flax in new lands such as Bakry, (2009); Nofal et al., 2011; Bakry et al., 2012 & 2015; Shedeed et al., 2016; Dawood et al., 2019 and Abd El- Fattah et al., 2020). The new lands are distinguished

in terms of their physical and chemical characteristics. Their texture is coarse and poor in organic matter and sometimes rich in calcium carbonate or salinity and its nutrients elements whether major or minor are considered scarce. The results presented by Shukry (2001) at the Western Mediterranean Coastal region give evidence that there was a high seed yield of flax than East of El-Kantara in Sinai and Tushki in the new valley. However, a highly significant increase of oil yield was recorded at Northern Coastal and Tushki soils and the opposite is true at El-Kantara soil under the same agriculture practices. Regarding El-Beltagi et al. (2008) which concluded that the presence of NaCl in growing media of flax “five cultivars differ in origin and growth habit” increased the plant tolerance mechanisms against salinity stress. However, Nofal et al. (2011) found that under sandy soil conditions of Nubaria district, the growth, fiber yield, seed yield, and oil % of flax were greater than the control by using zinc sulfate (2g/L) as a foliar application. These results indicated that flax could be grown successfully in new lands.

In connection with variabilities observed among flax varieties in their yield components and quality, which can be regarding that some flax varieties were adapted better to unfavorable soil conditions than others (Rezk et al., 2005, and Nofal et al., 2014 a & b). The flax crop usually is grown in Egypt as a dual-purpose crop, so Sakha-2 cultivar seems to be the most suitable variety as a dual purpose because it produced 98.5% of the highest-fiber yield of Agretic variety and 91.4% of the highest seed yield of Giza -8 cultivar (Bakry, 2009) at Nubaria district. In addition to that high flax seed (702 kg /fed) and oil yield (205 kg/fed) could be obtained by growing Giza -8 cultivar at the highest seeding rate (2250 seeds/m²), as shown in Tables (1&2). Furthermore, El-Beltagi et al. (2008) concluded that Ariane and Sakha -1 are considered salt-tolerant stress cultivars due to their increasing the activity of antioxidant enzymes. Moreover, Bakry et al. (2012) cleared that planting Giza-8 as a flaxseed variety varied than others for the production of seed and oil. However, sowing Vainking variety as fiber flax variety production was the best compared with the others when they were fertilized by KNO₃ foliar application. Also, Bakry et al. (2015) reported that Sakha -2 variety significantly surpassed Amon variety in majority of studied characters of Nubaria district with potassium soil application at the rate of (100kg/fed.) in combined with chelated zinc foliar application (5%) at the rate of 1.5 g/L (300g/fed.). The variability may be expected due to the differences in their origin, growth habit, the high diversity in genetic constitute, and environmental conditions of investigated cultivars under sandy soils. On the other hand, Dawood et al. (2019) revealed that Line-3; Linola, and Sakha -1 obtained positive effects on the nutritive value of flaxseed under investigation, with the yeast extract treatment at Nubaria district. In this connection, Rezk et al., (2005) and Nofal et al. (2014 a & b) concluded that the varieties varied on the same soil in growth and response to a specific fertilizer program. In this regard, attempts are made to increase crop productivity in new lands by many ways as applying organic manure and biofertilizers that used as a substitute the chemical fertilizer, besides, to improve physical, chemical, and biological properties of the soil and soil fertility (Khalil et al., 2000).

According to the results of El- Shimmy et al. (2006) using Nofatrin (as N- biofertilizer) on the yield and yield components of three flax cultivars under sandy soil (Ismailia Governorate). It was obtained that Sakha -1 cultivar surpassed Sakha -2 and Giza-8 in straw yield and fiber yield /plant as well as /fed., fiber percentage and fiber length. Whereas Sakha -2 ranked the first cultivar in seed yield /plant as well as /fed; oil percentage and oil yield/fed (Table 3).

Table 1. Effect of flax cultivars, seeding rates & their interaction on seed yield (Kg/fed.)

Cultivars	Seeding rates (seeds/m ²)				
	1500	1750	2000	2250	Mean
Giza 8	352.7	513.63	615.26	702.33	545.98
Sakha 1	394.61	478.58	529.86	579.14	495.55
Sakha 2	417.98	490.51	541.63	642.09	523.05
Agretic	308.96	359.44	505.13	581.09	438.65
Posnia	342.31	441.4	555.46	576.76	478.89
Olin	300.4	385.23	500.71	635	455.33
Opal	428.36	509.05	569.65	651.81	539.72
Szafir	340.89	417.26	488.36	578.55	456.27
Mean	360.78	449.39	538.26	618.35	491.69
LSD at 5%	Cultivars(V) 32.82: Seeding rates (SR)14.05: VXS 39.73				

Table 2. Effect of flax cultivars, seeding rates & their yield interaction on oil (Kg/fed.)

Cultivars	Seeding rates (seeds/m ²)				
	1500	1750	2000	2250	Mean
Giza 8	131.77	191.17	232.55	265.19	205.17
Sakha 1	147.58	177.11	202.51	222.06	187.31
Sakha 2	157.09	186.55	205.57	248.19	199.35
Agretic	119.85	140.61	195.03	224.02	169.88
Posnia	129.76	168.84	214.28	219.4	183.07
Olin	113.53	145.62	188.93	242.27	172.59
Opal	169.62	197.37	223.96	254.22	211.29
Szafir	129.33	158.91	184.46	219.89	173.15
Mean	137.32	170.77	205.91	236.91	187.73
LSD at 5%	Cultivars(V) 13.21: Seeding rates (SR)5.36: VXS 15.15				

From another point, Dawood et al. (2019) mentioned using different biofertilizers treatments i.e. mycorrhizal fungi; milk whey (the watery part of milk remaining after the coagulation of milk and separation of the curd); yeast extract on three flax varieties: Line-3, Linola, and Sakha -1, that all the treatments increased significantly seed yield and its components of the three flax cultivars and the yeast extract showed the highest significant increases in seed yield/fed and its nutritive value (oil, protein, flavonoid, and phenolic contents) for the three flax cultivars under investigation (Tables 4& 5).

Table 4: Effect of bio-fertilizer treatments on growth parameters and chemical content of flax plants grown under sandy soil conditions

Characters	Treatments					L.S.D. 0.05
	Control	Micro	Milk whey	Yeast extract (1)	Yeast extract (2)	
Shoot height (cm)	63.50	66.72	74.56	73.33	69.17	2.19
Root length (cm)	10.33	14.00	13.61	13.06	12.56	1.32
Number of basal branch	2.78	3.94	3.72	2.67	3.61	0.22
Shoot fresh wt (g)	9.85	23.18	22.28	17.88	25.31	1.05
Root fresh wt (g)	1.06	3.17	3.12	1.99	3.53	0.25
Shoot dry wt. (g)	2.78	6.31	6.18	4.84	6.86	0.22
Root dry wt (g)	0.35	0.98	0.78	0.48	0.92	0.19
Chlorophyll a mg/100g fresh wt	1.17	1.601	1.769	1.437	1.521	0.01
Chlorophyll b	0.489	0.501	0.522	0.512	0.468	0.10
Carotenoids	0.404	0.438	0.509	0.366	0.389	0.05
Total pigments	2.064	2.540	2.801	2.316	2.377	0.18
Total carbohydrate content (%)	17.82	19.74	20.42	20.77	22.37	0.53
Total soluble carbohydrate (%)	1.79	1.79	1.97	2.01	2.07	0.10
Polysaccharides (%)	16.03	17.94	18.45	18.76	20.3	0.51
IAA (ug/g fresh leaf)	26.02	33.25	37.35	40.64	47.15	3.62
Total phenolic(mg/100g fresh leaf)	41.13	52.84	46.87	54.44	59.97	1.38

Table 5: Effect of bio-fertilizer treatments on seed yield, its related characters and nutritive value of flax plants grown under sandy soil conditions

Characters	Treatments					L.S.D. 0.05
	Control	Micro	Milk whey	Yeast extract (1)	Yeast extract (2)	
Plant height (cm)	71.33	78.34	85.67	88.17	77.34	2.13
Fruiting zone length (cm)	24.43	30.22	33.78	32.11	30.11	1.19
Technical stem length (cm)	46.9	48.12	51.89	56.05	47.23	1.77
No. of basal branch/plant	2.67	3.67	3.89	3.67	4.11	0.33
Biological yield/plant (g)	10.97	16.80	20.87	21.75	17.91	1.17
No. of fruiting branches/plant	19.05	31.55	34.78	29.11	24.56	2.35
No. of Capsules/plant	64.00	88.78	115.66	122.67	110.67	7.17
Capsules yield/plant (g)	5.01	8.78	10.12	11.79	12.39	2.08
Seed yield/plant (g)	3.44	4.29	4.98	7.36	6.09	0.24
1000 seeds weight (g)	3.46	3.91	3.93	3.87	3.81	0.11
Straw yield (ton/fed)	1.42	2.11	2.66	2.42	2.87	0.21
Seed yield (kg/fed)	284.00	489.73	574.93	526.00	568.80	30.55
Oil content (%)	20.11	21.84	21.67	22.82	23.69	0.43
Protein content (%)	19.18	20.72	20.74	21.89	22.67	0.31
Total phenolic mg/100g dry seed	228.87	270.79	297.24	326.58	325.83	10.38
Total flavonoids mg/100g dry seed	24.64	28.38	28.34	31.75	33.06	0.34

Table 3. Mean values of seed yield, oil% and oil yield of three flax cultivars as affected by spraying Nofatrin fertilizer at three times

Treatments	Seed yield/plant(g)	Seed yield (Kg/fed)	Seed oil %	Oil Yield (Kg/fed)
Cultivars				
Sakha 1	0.47	502.7	38.91	195.8
Sakha 2	0.65	562.8	39.79	224.1
Giza 8	0.42	449.8	38.52	173.2
LSD 5%	0.04	19.18	0.21	4.82
Time of Nofatrin foliar application				
Control	0.34	450.5	38.13	171.9
30 days old	0.47	497.7	38.78	193.1
60 days old	0.59	531.4	39.59	210.6
90 days old	0.65	540.8	39.8	215.2
LSD at 5%	0.03	16.4	0.33	6.95

Regarding the results of Shukry et al. (2007), they stated that the inhibitory effects of calcareous soil of Tushki on the metabolic activities and fiber yield of flax plants can be improved by the addition of 1% dry manure. It is also improved to note that all organic manures improve the behaviors of several elements in soils through their active groups (fluvic and humic acids) which can retain the elements in complex or chelate forms and consequently improve the plant growth as well as quantity and quality of yield (Shafeek and Habbasha, 2000 and Nofal and Rezk, 2009). On another side, the results obtained by Nofal et al. (2011) indicated that Zn foliar feeding is important to correct the nutrient imbalance in flax plant Sakha -2 under undesirable soil conditions. In this connection, several authors mentioned the positive effect of micronutrients on flax yield and quality (Moawad, 2001; Mostafa and El-Deeb, 2003). Concerning the effect of some sources of K on three flax varieties i.e., Giza-8, Vaiking, and Eriane, Bakry et al. (2012) found that planting Giza – 8 as a flaxseed variety was the best for production seed and oil yields, however sowing Viking variety as fiber flax variety was the favorable for fiber production when fertilized by KNO₃ under reclaimed sandy soil conditions. Regarding, the obtained results by Shedeed et al. (2016) indicated that silicon foliar application with two sources i.e. potassium and magnesium in general, improved the nutritive status of Sakha-2 and Amon than the untreated plants and potassium silicate was the best fertilizer. Moreover, El-Fouly (1983); Nofal and Rezk (2009), and Gaballah et al. (2020) cleared that using balanced fertilizer plays an essential role in achieving a high yield of crops. They all reported that increasing the yield and improving its quality were associated with optimizing fertilizer use.

Conclusion

It might be thus concluded that using the most suitable varieties in the framework of balanced fertilization and using biofertilizers under new land conditions is recommendable for

getting relatively high fiber, seed, and oil yield with good nutritive value of oil yield of flax crop.

Conflict of interest

The authors hereby declare no conflict of interest.

Consent for publication

The authors declare that the work has consent for publication.

Funding Support

The authors declare that they have no funding support for this study

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How to cite this article:

Nofal, O.A. Rezk, A. I. & Abbas, M. M. (2020). The role of different fertilization strategies on the yield and quality of different flax varieties in the new lands. *Science Archives*, 1 (3), 84-88.

<http://dx.doi.org/10.47587/SA.2020.1302>