

Impact of Ascorbic and Folic Acids Foliar Application on Yield, Growth and its Attributes of Flax Cultivars

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ABSTRACT

Two field experiments were carried out in 2012/ 2013 and 2013/ 2014 seasons at Etay El-Baroud Agricultural Research Station, to investigate the response of cultivars Sakha 1, Sakha 2, Sakha 3 and Giza 9 to ascorbic and folic acids addition at 50 and 100 ppm on flax growth, fiber and seed yield and yield attributes and quality. Significant differences were detected among the studied cultivars, where; Giza 9 cultivar had significantly shorter plants, technical length, lower plant fresh and dry weights, but it had significantly higher number of fruiting branches, heavier 1000- seed weight, taller fruiting zone and seed yield per plant and Faddan. Ascorbic and folic acids application, generally, increased all the studied traits, especially folic acid at 100 ppm concentration, except for, fiber fineness and seed carbohydrate content. Sakha 2 plants treated with ascorbic acid at 100 ppm, had significantly the highest chlorophyll (b) in both seasons, chlorophyll (a+b) and oil percent in the second season, whereas plants of that variety had the tallest strands when treated with folic acid at 100 ppm in the second season.

Key words: Flax, variety, Ascorbic acid, Folic acid, Concentrations, Fiber yield, Quality.

INTRODUCTION

Flax (*Linum usitatissimum*, L.) is considered among the important sources of fiber and has been grown as a dual purpose crop (fiber and oil) in many countries as Egypt. EL-Hariri *et al.* (1998) pointed out the importance of flax as a national economy crop with large possibilities of exportation, fabrication and weaving industry.

Linseed (flax seed) oil quality is usually evaluated depending on the content of essential fatty acids (Johnson *et al.*, 2008). The omega 3, 6 and 9 groups of fatty acids all contains essential fatty acids necessary for good health (Morris, 2004). The main compound responsible for the antioxidant activity is ascorbic acid (Vitamin C) which is the most abundant antioxidant in flax seeds (Westscott and Muir, 2003 and Morris, 2005). Also, folic acid (vitamin B) is the most important of B-complex vitamins, because of its essential biochemical function in amino acids metabolism and nucleic acids synthesis (Andrew *et al.*, 2000). Meal remains after oil extraction is fed to animals as a protein supplement (Lay and Dybing, 1989).

Flax plants treated with ascorbic and folic acids significantly had increased growth parameters, as well as photosynthetic pigments. These treatments induced plants flowering and early maturity. Also, improved fiber yield, quality and flax seeds quality (Emam *et al.*, 2011). However, (EL-Bassiouny and Sadak, 2015) reported that ascorbic acid application stimulated the accumulation of total soluble carbohydrates in the flax stem of Sakha 3, Giza 8 and Ariane cultivars.

This investigation aimed to study the effect of two antioxidant vitamins, i.e.; ascorbic acid (ASC or vitamin C) and folic acid (FA or vitamin B₉) on growth, yield and its attributes besides seed protein and oil content of four flax cultivars.

MATERIALS AND METHODS

The present study was carried out at the Agricultural Research Station, Etay El-Baroud, Agricultural Research Center, in 2012/ 2013 and 2013/ 2014 seasons. Experiments, in both seasons, were carried-out in a split-plot design with five replications. The studied cultivars (Sakha 1, Sakha 2, Sakha 3 and Giza 9) occupied the main plots. Ascorbic and folic acids concentrations (50 and 100 ppm) were allocated to the sub-plots. The sub-plot area was 6 m². Sowing dates were November 3rd in both seasons at 70 kg/ Faddan. Ascorbic and folic acids with the two concentrations sprayed two times at (50 and 70 days after sowing). Cultural practices were applied as recommended for commercial production of flax. The following characters were recorded, for each sub-plot, in both seasons:

- 1-Vegetative characters: plant fresh and dry weights at 90 and 120 days after sowing (DAS), plant height at 90, 120 DAS and harvest, technical length (average of 10 randomly-chosen and guarded plants).
- 2-Yield attributes: fruiting zone, number of fruiting branches, number of capsules and seeds/ plant and seed yield/ plant (average of ten randomly-chosen and guarded plants).
- 3-Seed and fiber yield (kg/ Faddan): conversion of seed and fiber yields obtained from each sub-

plot (6 m^2) to its equivalent seed and fiber yield (kg/ Faddan). After harvest and deseeding plants, retting process was carried out on straw for determination of fiber percentage as follows:

$$\text{Total Fiber (\%)} = \frac{\text{Fiber yield (kg/ plot)}}{\text{Straw yield (kg/ plot)}} \times 100$$

4-Fiber fineness (N.m): fiber fineness in metrical number (N.m) was determined according to Radwan and Momtaz (1966) using the following equation:

$$N.m = \frac{NL}{G}$$

Where, N: number of fibers (20 fibers each 10 cm), L: fiber length (mm), G: weight of fibers (mg).

- 5- Chlorophyll content (mg/ g. f. wt): was quantitatively determined using the equations reported by Moran and Porath (1980) as following:

$$\text{Chlorophyll a} = 12.0 (E_{663.8} - E_{750}) - 3.11 (E_{646.8} - E_{750}).$$

$$\text{Chlorophyll b} = 20.78 (E_{646.8} - E_{750}) - 4.88 (E_{663.8} - E_{750}).$$

$$\text{Chlorophyll a+b} = 17.67 (E_{646.8} - E_{750}) + 7.12 (E_{663.8} - E_{750}).$$

- 6- Oil percentages (%): was determined by extracting using Soxhlet apparatus according to the method described by A.O.A.C. (1990).

- 7- Protein percentage (%): nitrogen content in flax seeds was determined using modified micro-Kjeldahl method. Crude protein content was calculated by multiplying nitrogen content by 6.25 (A.O.A.C., 1988).

- 8- Carbohydrates content (%): total carbohydrates in dried flax seeds was determined using phenol sulphuric method (Dubois *et al.*, 1956).

Data were statistically analyzed according to Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Vegetative traits:

Results presented in Table (1) showed that both, flax cultivars, ascorbic and folic acids concentrations had significant effect on the studied vegetative traits in the two seasons. However, the interaction effects were significant on plant fresh weight at (120 DAS) in the first season, plant height at (90 DAS), harvest and technical length in the second season, besides, plant fresh weight and plant dry weight at (90 DAS) in both seasons.

Concerning flax cultivars plant height, the obtained results revealed that, Giza 9 had the shortest plants at 90, 120 DAS and harvest, respectively, in the first season (95.32, 108.30 and 112.12 cm) and the respective samples in the second season (89.04, 106.64 and 115.28 cm). However, Sakha 1 plants were, generally among the tallest at the three plant samples in the two seasons. These

results might due to genetic differences among the studied cultivars.

Similar trend observed for technical length, where Giza 9 variety had the shortest technical length (92.40 and 93.92 cm) in the first and second seasons, respectively, while Sakha 3 and Sakha 1 had the tallest technical length in the two respective seasons.

Plant fresh and dry weights at 90 and 120 DAS samples, presented results in Table (1), indicated that, there were no obvious trend among the studied cultivars within and between seasons, especially in plant fresh weight. Conversely, Giza 9 plants were approximately of least dry weights.

Regarding ascorbic and folic acids (ASC and FA) concentration effects, on growth traits, results pointed out that, foliar application of both (ASC and FA) at 50 or 100 ppm significantly increased plant height in the three growth samples of both seasons. Foliar application of (FA) at 100 ppm concentration produced the tallest plants (105.40, 117.05 and 125.0 cm) and (117.05, 122.20 and 128.50 cm) at 90, 120 DAS and harvest, respectively, in the first and second seasons. Similar results reported by Emam *et al.* (2011). Folic acid application at 100 ppm gave the tallest technical length (102.95 cm) in the first season, while foliar application of (ASC or FA) at 50 or 100 ppm, significantly increased technical length compared to control in the second season. Also, sprayed flax plants with 100 ppm folic acid produced the heaviest plant fresh and dry weight in both seasons. These results were in agreement with those of Liso *et al.* (1988) and De-Tillio *et al.* (1999), who reported that, vitamins play an important role in the regulation of cell division and elongation.

With regard to interaction between variety and vitamin concentration effects on flax growth characters, results presented in Table (4) indicated that significantly the tallest plants at (90 DAS) resulted from Sakha 1 treated with 100 ppm (FA), however at harvest Sakha 1 variety treated with 100 ppm (ASC), 50 and 100 ppm (FA) and Sakha 2 treated with 100 ppm (FA) in that season, showed significantly the tallest plants. Sakha 2 variety treated with (100 ppm FA), also gave significantly the tallest technical length (117.80 cm) in the second season.

Considering plant weight, both Sakha 2 and Sakha 1 treated with 100 ppm (FA) produced significantly the heaviest plant fresh weights at (90 DAS) in the first and second seasons, respectively. Sakha 2 treated with 100 ppm (FA) and Giza 9 treated with 100 ppm of (ASC and FA) gave significantly the heaviest plant fresh weight at (120 DAS) in the first season. However Sakha 1 treated with 100 ppm (FA) showed significantly the heaviest plant dry weight (5.77 g) at (120 DAS) in 2013/ 2014 season.

Yield and yield components:

There were significant differences between the studied cultivars in seed and fiber yields and all yield attributes in both seasons, except for, number of seeds/ capsule, biological and straw yields/ Faddan in both seasons and seed yield/ plant in the second season (Table 2). Giza 9 cultivar that had the shortest plants and technical zone, produced the lowest fiber yield (548.56 and 596.0 kg/ fed) in the first and second seasons, respectively. On contrast, that variety had the tallest fruiting zone (21.32 cm) and maximum number of capsules/ plant (20.12) in the first season, 1000-seed weight (11.10 and 11.22 g), seed yield (442.39 and 488.56 kg/ fed) and seed yield (1.37 and 1.32 g/ plant) in both seasons. However, Sakha 2 significantly followed Giza 9, where it had (5.52) fruiting branches/ plant, 20.12 numbers of capsules/ plant, 1.22 g seed yield/ plant and 479.03 kg seeds/ fed in the first season, besides, fruiting zone length (21.92 and 23.84 cm) and 1000-seed weights (10.85 and 11.08 g) in the two respective seasons.

Obtained results, also revealed that, vitamins foliar application significantly increased flax fiber and seed yields and their attributes compared to control treatment in both seasons, where, treated plant with (ASC or FA) at (50 or 100 ppm) produced higher capsule numbers/ plant, 1000-seed weight, seed yield/ plant and fiber yield/ fed in the second season. On the other hand, 100 ppm FA produced tallest fruiting zone (22.55 cm), highest number of fruiting branches/ plant (5.60 cm), biological yield (4.11 ton/ fed) and fiber yield (654.15 kg/ fed) in 2012/ 2013 season. These findings were in agreement with that obtained by Robinson (1973) Sahu *et al.* (1993), Andrew *et al.* (2000), Samirnoff and Wheeler (2000) and El-Bassiouny *et al.* (2005), who improved the performance of (*Brassica juncea*) and flax cultivars by seed treatment with vitamin B₆ (FA) which might be attributed to their effect on regulation of protein and nucleic acid biosynthesis. Barth *et al.* (2006) reported that, ascorbic acid is very important for the regulation of photosynthesis, flowering and senescence.

Obtained results in Table (4) also, pointed out that, treated Sakha 1, Sakha 2 and Sakha 3 cultivar plants with (100 ppm FA) showed the highest fiber yields (666.40, 679.60 and 679.80 kg/ Faddan, respectively), in the first season. However, in the second season, untreated Sakha 2 plants with vitamin showed tallest fruiting zone and highest number of capsules/ plant. In the contrary, Sakha 1 and Giza 9 plants treated with 50 ppm of (FA and ASC), respectively, produced the highest number of fruiting branches and seed yield/ plant. Al-Jabir (2010) indicated that ascorbic acid accelerated photothynthesis and carbohydrate production and

that led to increased number of flowers and seed production in Jenugreeex.

Fiber and Seed quality:

The studied cultivars were statistically differed in all seed and fiber quality traits, except for, fiber fineness in the two seasons (Table 3). Sakha 1 variety had significantly the lower fiber percentage, stand length, chlorophyll (a) content and protein content in the two seasons and chlorophyll (a+b) in the first season. Sakha 2 and Sakha 3 seeds had significantly lower carbohydrate and oil percentages, respectively, in both seasons. Differences between the studied cultivars might be due to genetical differences and the interactions with environment.

With regard to vitamin effects, results presented in Table (3) revealed that, vitamin foliar application, significantly increased all the studied traits, except for fiber fineness in the two seasons. Ascorbic acid application at 100 ppm concentration showed significantly higher values of stand length (82.87 and 82.91 cm), chlorophyll a (1.44 and 1.55 mg/ g.f.wt), chlorophyll b (0.86 and 0.93 mg/ g.f.wt) and chlorophyll a+b content (2.22 and 2.48 mg/ g.f.wt), oil (39.87 and 39.04 %), protein (24.24 and 23.86 %) and total carbohydrate (24.11 and 24.46 %) contents in both seasons, besides, fiber percent (21.17%) in the second season. These results, generally, confirmed with those obtained by Robinson (1973), Smirnoff and Wheeler (2000) and El-Bassiouny *et al.* (2005) who reported that, ascorbic acid application had favorable effect on photosynthesis, cell division and differentiation and that led to increased plant and stand height. Beyer (1994) reported that the increase of chlorophyll content due to ascorbic acid application depends on the scavenging of reactive oxygen species by this antioxidant molecule and removing them directly from the cytoplasm. Moreover, it has a supplementary role in protecting or regenerating oxidized carotenoids or tocopherols (Shao *et al.*, 2006).

Considering variety × vitamin concentration effects on both fiber and seed quality. Results in Table (4) revealed that, Sakha 2 plants treated with (100 ppm ASC) produced significantly the highest chlorophyll (b) content (0.92 and 0.96 mg/ g.f.wt) in the two successive seasons and chlorophyll (a+b) content (2.52 mg/ g.f.wt) and oil percent (41.93%) in the second season. On the other hand, the tallest stand (85.14 cm) in the second season resulted from (100 ppm FA) application to Sakha 2 variety.

As for, fiber percent, Sakha 1 variety treated with (50 or 100 ppm FA), sakha 2 at (100 ppm FA) and Sakha 3 treated with (50 or 100 ppm ASC and FA) produced significantly the highest values (21.32, 21.66, 21.90, 21.12, 21.60, 21.08 and 21.94%, respectively) in the first season.

These results clarified that, the studied cultivars were of different response to vitamin concentrations as a results of G × E interaction.

In conclusion, the present study revealed that, there were significant differences among the studied cultivars, in vegetative growth traits and fiber yield. In addition, the present study indicated the beneficial effects of foliar ascorbic and folic acids application on growth, yield and yield components, besides, seed and fiber quality, indicating the possible improvement of fiber and seed yield and quality characters.

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الملخص العربي

تأثير المعاملة بحامض الإسكوربيك والفوليك على النمو والمحصول ومكوناته لأصناف الكتان

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أجريت تجربتان حقليتان في محطة البحوث الزراعية بابيتساى البارود خلال الموسمين ٢٠١٣/٢٠١٢ ، ٢٠١٤/٢٠١٣ لدراسة تأثير الأصناف(سخا ١ ، سخا ٢ ، سخا ٣ ، جيزة ٩) والرش بحمض الإسكوربيك وحمض الفوليك بتركيز ٥٠ ، ١٠٠ جزء/ مليون لكل منها بالإضافة إلى المعاملة القياسية(control) على صفات النمو ومحصول البذور والألياف ومكوناتها وصفات الجودة في محصول الكتان. وقد سجلت اختلافات معنوية بين أصناف الكتان الأربع حيث كانت نباتات الصنف جيزة ٩ أقصر النباتات- أقصر طول فعال وأقل وزن رطب وجاف- إلا أنها تحتوى على أكبر عدد من الأفرع التمرة، أقل وزن للملائمة بذرة- والمنطقة التمرة بها طويلة وكان المحصول البذرى للنبات والفادان لهذا الصنف مرتفعاً. وبوجه عام أدت إضافة كل من حمض الإسكوربيك والفوليك إلى زيادة الصفات تحت الدراسة وكانت هذه الزيادة أكبر ما يمكن في حالة إضافتها بتركيز ١٠٠ جزء/ مليون خاصة بالنسبة لصفات النعومة ومحتوى البذور من الكربوهيدرات.

كما أدت معاملة الصنف سخا ٢ بحمض الإسكوربيك بتركيز ١٠٠ جزء/ مليون إلى زيادة محتوى الأوراق من كلوروفيل(ب) في كلا موسمي الزراعة، كلوروفيل(A + ب) ونسبة الزيت في الموسم الثاني فقط- في حين أعطت نباتات نفس الصنف أطول خيط ليفي في الموسم الثاني عند معاملتها بحمض الفوليك بتركيز ١٠٠ جزء في المليون