Available online freely at www.isisn.org

Bioscience Research

Print ISSN: 1811-9506 Online ISSN: 2218-3973

Journal by Innovative Scientific Information & Services Network

RESEARCH ARTICLE BIOSCIENCE RESEARCH, 2017 14(1): 57-67. **OPEN ACCESS**

Effect of hemin, Fe-EDTA and arginine on growth, yield and chemical constituents of two sesame cultivars grown under sandy soil conditions

Bakry A. Bakry[1*], Maha Mohamed-Shater Abdallah[2], Omar M. Ibrahim[3] and Hala Mohamed Safwat El-Bassiouny[2]

[1]Field Crops Research Department, National Research Centre, 33 El Bohouth St., Dokki, Giza, P.O. Box12622, **Egypt**
[2]Botany Department, National Research Centre, 33 El Bohouth St., Dokki, Giza, P.O. Box12622 **Egypt**.
[3]Plant Production Department, Arid Lands Cultivation Research Institute, City of Scientific Research and Technological Applications (SRTA-City), New Borg El-Arab, Alexandria 21934, **Egypt**

***Correspondence:** bakry_ahmed2004@yahoo.com **Received:** 03 Feb. 2017 **Accepted:** 28 Feb. 2017 **Published online:** 09 March. 2017

Improving the productivity of field crops grown in low productive soils such as newly reclaimed sandy soil has become a major concern of many researchers in Egypt. Two field experiments were conducted during two successive seasons (2014 and 2015) at the Research and Production Station of National Research Centre, Nubaryia district, Beheira Governorate, Egypt. The experiments aimed to study the effect of foliar application with arginine (at 50mg/l), Fe-EDTA (50 &100 mg/l) and/or Hemin at (50 &100 mg/l) on two sesame cultivars (Shandwil-3 and Giza-32). Data clearly indicated that, all treatments significantly increased the growth criteria, photosynthetic pigments and carbohydrate content, as well as yield and yield attributes (number of seeds/pod, seed yield/plant, biological and seed yields) as compared with the untreated plants. The most effective treatment was 50 mg/l Arg. + 100 mg/l Fe-EDTA and 50mg/l Arg. + 50 mg/l Fe-EDTA. Different treatments increased markedly total carbohydrates content, oil%, and oil yield of the yielded seeds compared with those of the untreated plants. Concerning the effect of varietal differences, data illustrates that, Shandawel-3 surpassed Giza-32 cultivar in all determined characters, except for plant height It could be concluded that improving sesame productivity of both seeds and oil under sandy soil conditions could be achieved by foliar application of 50 mg/l Arginine and 50 mg/l Fe-EDTA.

Keywords: Sesame, Arginine, Fe-EDTA, Hemin, Growth characters, Yield and yield attributes.

INTRODUCTION

Sesame (*Sesamum indicum* L.) is one of the most ancient and important oilseed crop in the tropics and subtropics, however most of its cultivated area are grown in developing countries where generally grown via small holders. Sesame crop has an important advantage because it can be grown under fairly high temperature, low water supply and low levels of other inputs (Ashri et al. 1989). Sesame serves as a nutritious food for humans and is utilized widely in bakery and confectionery products as the seed is contain of 55% lipid and 20% protein. The oil is very steady because of the presence of some antioxidants like sesamin, sesamolin and sesamol (Suja et al. 2004).

In Egypt, sesame is consider a food crop rather than oilseed crop because most of its seeds production is used for snacks, dessert, bakery products, tehena and halawa purposes. The cultivated area of sesame in Egypt improved markedly during the last few years, while, the productivity was not increased by the same relative. However, the local production of sesame uncover the national requirements, thus a lot of amount of sesame seed was imported from abroad every year. So, raising the productivity can be achieved through generate a new cultivars with high yield potentiality. In addition to, application the appropriate cultural practices like natural product fertilization, and irrigation. Sandy soils in dry land areas are marginal for crop production. Sesame is adapted in numerous soil types, drought- tolerant and grows on poor fertile soil (Abdullahi et al. 2013) like sandy soils which distinguish by low fertility, low organic matter, and low water-holding capacity. In recent years there is a tendency to use naturally-occurring compounds such as amino acids to realize plant growth regulation. Amongst them, arginine is important amino acids; it is the precursor of polyamines biosynthesis that produced via decarboxylation of arginine through arginine decarboxylase to produce putrescine, (Bouchereau et al. 1999**;** Mohamed et al. 2015). Arginine has been involved as vital modulators in the diversity of growth, physiological and developmental processes in higher plants (Abdel Monem, 2007). The treatment of arginine improved a growth and increased fresh and dry weights, endogenous plant growth regulators, photosynthetic pigments and yield and yield component in wheat (El-Bassiouny et al. 2008). Moreover, Khalil et al. (2009); Sadak et al. (2012) found that, the positive role of arginine in enhancing the suppression occurs as the outcome of exposing plants to stress.

Iron is a necessary micronutrient for plants which deficiency introduces the main agricultural problem in the world. Iron is hardly accessible in neutral to alkaline soils, performance plants iron insufficiency although its availability (Rout and Sahoo, 2015). It is necessary for almost all living organisms due to iron performs important function in metabolic processes like DNA synthesis, respiration, and photosynthesis. It is necessary for the servicing of chloroplast structure and function. In addition, several metabolic pathways are activated by iron, and it is cofactors constitutive of several enzymes. Iron is more define nutrient to plant growth and metabolism, because of a minimal solubility from the oxidized ferric of in aerobic medium (Samaranayke et al. 2012). Iron biofortification includes improving iron absorption and translocation *via* inserting genes responsible to biosynthesis of the mugineic acid. Other way is to increment iron concentrations in rice by overexpression from the nicotianamine synthase gene. Nicotianamine, chelates mineral cations, like Fe^{+2} and Zn^{+2}, is biosynthesis of methionine through S-adenosyl methionine synthase.

Hemin and hematin belong to heme (ferroprotoporphyrin IX) compounds. In animals and recently in plants, hemin and hematin were showed to produce HO^{-1} expression on alfalfa (Han et al. 2007), on wheat (Wu et al. 2010), on tomato (Xu et al. 2010a); on rice germinating seeds (Liu et al. 2007). The hemin (product of glycine and ALA 5-aminolevulinic acid,) many investigators have declared positive relations among the ability of glycine betaine and proline accumulation and stress resistance (Meloni et al. 2001). Hormone-like influences of hematin and hemin were also discovered. Hematin and NaCl solution, when were present together, greatly promoted germination process by promoting the activities of amylase in wheat (Xu et al. 2006) and rice seeds (Liu et al. 2007).

So, the aim of this work is to study the physiological role of arginine, iron and/or hemin to improve growth, chemical constituents, yield and oil content of two sesame cultivars as an important source of oil and also enhancing growth in reclaimed sandy soil.

MATERIALS AND METHODS

In order to investigate the physiological role of arginine, iron and/or hemin to improve growth, chemical constituents, yield and oil content of two sesame cultivars a field experiments in split–plot design with three replications were conducted in 2014 and 2015 seasons at the Research and Production Station of National Research Centre, Nubaryia district Beheira Governorate, Egypt. The soil of the experimental site is sandy with 92.5 % sand, 4.4 % silt and 3.1 % Clay. Two sesame cultivars (Shandweel-3 and Giza-32) were assigned to the main plots in RCBD, while the foliar application concentrations of treatments were applied twice at 30 and 45 days after planting as follow:

1. Control

2. Hemin at two levels of (50 and 100 mg/l).
3. Fe-EDTA at two levels of (50 and 100 mg/l).
4. Arginine at level of (50 mg/l).
5. Arginine (50 mg/l) + hemin (50 mg/l).
6. Arginine (50 mg/l) + hemin (100 mg/l).
7. Arginine (50 mg/l) +Fe EDTA (50 mg/l).
8. Arginine (50 mg/l) + Fe EDTA100 mg/l).

The treatments were arranged in the sub plots. Each sub-plot area was 12 m^2 (4 m width and 3 m length) and consisted of six rows. Seeds of (Shandweel-3 and Giza-32) cultivars were hand planting in hills 20 cm apart at 15^{th} May in the 1^{st} and 2^{nd} seasons. Calcium super-phosphate (15.5% P_2O_5) at a rate of 150 kg/feddan (one feddan = 0.42ha) were applied at pre-sowing. Urea was used a source of nitrogen and was applied through three equal doses at 30, 45 and 60 day after planting at the rate of 45 kg N/feddan. Potassium sulfate (48% K_2O) was applied at two equal doses of 50 kg/feddan. Irrigation was carried out using the new sprinkler irrigation system where water was added every 5 days. All other cultural practices were carried out as recommended for sesame production under sandy soil conditions. Plant samples were taken after 45 days from sowing for determining the growth characters and some biochemical parameters. Growth parameters in terms of, shoot length (cm), shoot fresh and dry weight (g) and photosynthetic pigments (Chlorophyll a and b and carotenoids contents as (mg/g fresh wt.) were determined in the fresh leaves by using the method of Lichtenthaler and Buschmann, (2001). Plant samples were dried in an electric oven with drift fan at 70°C for 48 hr till constant dry weight for determining total carbohydrate content (mg/g dry wt.) according to Herbert et al. (1971).

At harvest, random sample of ten guarded plants for each experimental unit were taken and plant height (cm), capsules numbers per plant, weight of seeds/plant (g), seed index and seed yield $plant^{-1}$. Seed yield was determined per plot then seed yield (Kg/feddan) was calculated. Oil yield (Kg/feddan) was estimated by the multiplication of oil percentage by seed yield (Kg/feddan). Seed oil content was determined using Soxhlet apparatus and petroleum ether (40-60^oC) according to AOAC (1990).

Statistical analysis:

All data collected were analyzed with analysis of variance (ANOVA) procedures using the Co-Stat Statistical Software Package. Differences between means were compared by LSD at 5% level of significant (Gomez and Gomez, 1984). Bartlett's test revealed error homogeneous so, the combined analysis was conducted.

RESULTS AND DISCUSSION

Variations between sesame cultivars

The present results highlight a significant variation in most of vegetative growth parameters; photosynthetic pigments and total carbohydrate content of two sesame cultivars (Tables 1). Shandwil-3 cultivar was characterized by highest shoot fresh and dry weight; chlorophyll a, carotenoids, total pigments and total carbohydrate. It is worthy to mention that Shandwil-3 cultivar showed more adaptation to the conditions of sandy soil than the other cultivar Giza-32 and reflected on the highest significant value of seed yield. The significant variations between two sesame cultivars may be due to the differences of these varieties in genetic constituent, origin and/or growth habit. El-Habbasha et al. (2007) stated insignificant differences between two sesame cultivars concerning all characters; except for plant height in plants those received different combinations between organic and inorganic fertilizations. While, Debnath et al. (2007) reported the existence of genotype specific responses in growth parameters interpreted by variation occurred in performance of individual genotypes after different biofertilizer application.

Variations in vegetative growth parameters, and biochemical constituents of sesame cultivars under effect of Hemin, Fe-EDETA and Arginine

All applied treatments showed a significant variations in most investigated parameters (vegetative growth parameters, photosynthetic pigments, as well as carbohydrate as shown in Tables 2. It is obvious that arginine 50 mg/l + Fe EDTA 50 mg/l treatment showed the highest significant increase in fresh and dry weight of shoots, shoots length, photosynthetic pigments and total carbohydrate. These results are in good harmony with those obtained by Nassar et al. (2003), who concluded that the main role of all arginine induced significant increases in growth (fresh and dry weights) of bean plants. El-Basiouny et al. (2008) demonstrated that, the positive effect of arginine may be due to arginine is a suitable nitrogen source for improving growth

Table 1: Effect of cultivars on morphological characters and chemical contents of sesame plants under newly reclaimed sandy soil.

Cultivars	Shoot length (cm)	Shoot fresh wt. (g)	Shoot dry wt. (g)	Photosynthetic pigments (mg/g fresh wt.)				Total Carbohydrates (mg/g dry wt.)
				Chl. a	Chl. b	Carotenoids	total pigments	
Shandwil-3	105.63	113.91	21.22	1.39	0.58	0.50	2.47	207.36
Giza-32	102.31	90.24	14.19	1.03	0.59	0.35	1.97	205.06
LSD 0.05	1.015	3.22	2.17	0.23	NS	0.11	0.38	1.33

Table 2: Effect of hemin, Fe-EDTA and Arginine and their interactions on morphological, criteria, photosynthetic pigments and total carbohydrates contents of two sesame cultivars.

Treatments (mg/l)	Shoot length (cm)	Shoot fresh wt. (g)	Shoot dry wt. (g)	Photosynthetic pigments (mg/g fresh wt.)				Total carbohydrates (mg/g dry wt.)
				Chl. a	Chl. b	Carotonoides	Total pigments	
T1	85.76	56.82	9.50	0.78	0.40	0.25	1.43	181.71
T2	94.26	79.01	12.20	1.03	0.59	0.29	1.90	187.45
T3	107.03	94.06	13.50	1.21	0.56	0.44	2.21	201.00
T4	91.40	81.96	12.45	1.07	0.60	0.45	2.12	201.30
T5	103.71	105.38	15.40	1.28	0.59	0.37	2.23	219.95
T6	102.95	98.83	15.45	1.18	0.52	0.38	2.08	194.30
T7	107.13	121.33	20.25	1.30	0.65	0.42	2.36	209.80
T8	103.35	109.30	18.33	1.27	0.66	0.51	2.44	217.00
T9	126.45	139.90	34.80	1.55	0.63	0.56	2.73	222.20
T10	117.66	134.20	25.15	1.46	0.69	0.59	2.73	227.40
LSD 0.05	3.19	4.13	2.14	0.11	0.08	0.11	0.23	13.19

T1: Control,T2: Hemin 50 ,T3: Hemin100,T4: Fe EDTA 50,T5: Fe EDTA 100,T6: Arginine 50,T7: Arginine 50,+ hemin 50,T8: Arginine 50 + hemin 100,T9: Arginin 50 + Fe EDTA 50,T10: Arginine 50 +Fe EDTA 100

rate of wheat plant. Also, the same authors found that, the arginine treated wheat plants had a high growth rate, leaf chlorophyll total carbohydrate contents. The increases in carbohydrates were closely correlated to the stimulation of leaves area chlorophyll biosynthesis. In addition, Kao (1994) confirmed that, the application of arginine on maize induced the retardation of leaf senescence through the retardation of chlorophyll loss. In addition, Paschalidis and Roubelakis–Angelakis (2005) demonstrated that, polyamines, their precursor arginine and their biosynthetic enzymes are involved in the stimulation of cell division, expansion & differentiation and vascular development in tobacco plant. They could facilitate at stabilize membrane and wall properties (Velikov et al. 2000) and care for plant to unfavorable stress conditions (Mo and Pua, 2002). It could be recommended that amino acids could performance as components of salt tolerance mechanism and build up a suitable osmotic potential inside the cell in order to compete the effects of which substituted nitrate in the vacuoles.

Iron is vital of different cellular proceedings in plants. It is different function such as cellular respiration, chlorophyll biosynthesis, and photosynthetic electron transmits. It performs the cofactor for the broad set of plant functions (cytochromes, antioxidants enzyme include iron as a cofactor). In Fe-S proteins, iron is connected with cysteine and inorganic sulfur (Marschner, 1995). Thus, it is concluded that, iron insufficiency has the remarkable influenced on plant growth and development (Bashir and Nishizawa, 2013; Vigani et al. 2013; Rout and Sahoo, 2015).

Application of hemin increased growth parameters, photosynthetic pigments and total carbohydrates compared to control plant (Table 2). Abd El- Monem et al. (2013) indicated that, the application of hemin increased growth parameters on barley plant. Also, Xu et al. (2010 b) observed that, treatment with ALA improved growth for kudzu plant via rising photosynthetic pigment contents and photosynthetic rate.

Variations in vegetative growth criteria and some biochemical constituents of leaf under interaction effect between sesame cultivars and chemical treatments

All applied treatments showed significant variations in most investigated parameters in term of vegetative growth parameters, photosynthetic pigments and total carbohydrate when compared to control plant as shown in Table 3. Exogenous application of arginine and hemin at concentrations as well as arginine and Fe EDTA gave a marked significant increase than that of treatments without arginine. Data also showed that, the all treatments were more effective on Shandwil-3 cultivar than Giza -32. Table 3 clearly shows that the effect of 50mg/l arginine +50mg/l Fe EDTA and 50mg/l arginine +100mg/l Fe EDTA were the most effective treatments in both cultivars. Arginine induced significant effects on various biological aspects in plants may act as growth stimulants. This amino acid played a role on metabolic activities relevant to growth through increasing the efficiency of water uptake and utilization as well as protecting the photosynthetic pigments (Table 3), photosynthetic pigments as well as significantly higher levels of carbohydrates (Table 3). In addition, the positive effect of amino acid may be due to that, amino acid are an acceptable nitrogen source for increased growth rate of shoots (Abdallah et al. 2015). El Bassiouny et al. (2008) pointed out that, amino acids may play an important role in plant metabolism and protein assimilation which necessary for cell formation and consequently increase fresh and dry mater.

Numerous visible effects associated with iron concentrations El Bassiouny et al., (2005) found that, the foliar application of Fe EDTA significantly increased the growth parameters, chlorophyll and carbohydrates contents of Hibiscus sabdariffa plants. Also, Pande et al. (2011) found that, Fe supply increased growth leaf chlorophyll concentration of *Mentha spicata* L. plant.

The hemin (product of glycine and ALA 5-aminolevulinic acid,) many investigators have declared positive relations among the ability of glycine betaine and proline accumulation and stress resistance (Meloni et al. 2001). These results are in a good harmony with those obtained by Watanabe et al. (2006) observed the treatment of ALA (precursor of Hemin) enhanced the growth of grapevines plants. The higher output was linked to a rise in photosynthetic rate and CO_2 fixation and decreased emission of CO_2 in darkness. Also, Xu et al. (2010 b) established that treatment of hemin increased growth of kudzu plant via enhancing photosynthetic pigments and photosynthetic rate. ALA works as cofactors of respiratory enzymes, and photosynthetic pigments in plants (Granick, 1961).

Variations between sesame cultivars in seed yield and yield components

It is clear that Shandwil-3 cultivar showed positive effect in all the studied characters, except plant height and also the highest seed yield/feddan (701.75Kg) followed by Giza-32 cultivar under control treatment as shown in Table 4. Regarding Shandwil-3, the highest significant increase in oil yield kg/fed. The increases in oil yield (Kg/feddan) in Shandwil-3 might be due to the increases the number of capsules/plants, the capsules weight/plant, seed yield/plant and seed yield (Kg/feddan). Similar results were observed by Singravel et al. (1998), who found that, the occurrence of significant varietal differences between 4 varieties concerning seed yield/plot under the influence of these inoculants. Integrated nutrient management was reported to enhance sesame yield and yield attributes.

Variations in seed yield, yield components, oil yield and carbohydrate % of sesame cultivars under effect of hemin, Fe-EDTA and arginine

All applied treatments showed a significant increments in most investigated parameters (plant height, biological yield, seed yield (Kg/feddan), oil yield (Kg/feddan), as well as carbohydrate content as shown in Tables 5. It is obvious that 50 mg/l arginine + 50mg/l Fe EDTA treatments showed the highest significant increase in all the studied characters, except seed yield (Kg/feddan). These increases in yield and yield components might be due to the all treatments used stimulation of physiological processes that were reflected on

Table 3: Effect of hemin, Fe-EDTA and Arginine and their interactions on morphological, chemical constituents of two sesame cultivars under sandy soil conditions.

Cultivars	Treatments (mg/l)	Shoot length (cm)	Shoot fresh wt. (g)	Shoot dry wt. (g)	Photosynthetic pigments (mg/g fresh weight)				Total carbohydrates (mg/g dry wt.)
					Chl. a	Chl. b	Carot	Total pigments	
Shandwil-3	T1	86.75	58.3	9.7	0.91	0.32	0.32	1.55	188.3
	T2	95.19	81.1	13.7	1.12	0.61	0.37	2.10	190.2
	T3	106.73	93.9	14.0	1.26	0.54	0.53	2.33	199.9
	T4	92.05	79.1	12.9	1.12	0.55	0.54	2.21	201.3
	T5	110.25	121.6	18.5	1.54	0.52	0.42	2.48	222.6
	T6	102.64	105.2	18.1	1.33	0.47	0.42	2.22	195.3
	T7	114.45	147.5	26.0	1.44	0.73	0.52	2.69	205.3
	T8	111.33	135.2	25.1	1.54	0.69	0.57	2.80	214.8
	T9	121.35	161.5	44.3	1.88	0.62	0.65	3.15	225.8
	T10	115.55	155.7	29.9	1.74	0.72	0.68	3.14	230.1
Giza-32	T1	84.77	55.3	9.3	0.65	0.47	0.18	1.30	175.1
	T2	93.33	76.9	10.7	0.93	0.56	0.21	1.70	184.7
	T3	107.33	94.2	13.0	1.15	0.58	0.35	2.08	202.1
	T4	90.75	84.8	12.0	1.02	0.64	0.36	2.02	201.3
	T5	97.17	89.2	12.3	1.02	0.65	0.31	1.98	217.3
	T6	103.25	92.6	12.8	1.03	0.56	0.34	1.93	193.3
	T7	99.81	95.2	14.5	1.15	0.56	0.32	2.03	214.3
	T8	95.37	83.4	11.6	1.00	0.63	0.45	2.08	219.2
	T9	131.55	118.3	25.3	1.21	0.63	0.46	2.30	218.6
	T10	119.76	112.7	20.4	1.17	0.65	0.49	2.31	224.7
LSD 0.05		4.33	3.25	2.18	0.18	0.15	0.12	0.21	4.46

T1: Control,T2: Hemin 50 ,T3: Hemin100,T4: Fe EDTA 50,T5: Fe EDTA 100,T6: Arginine 50,T7: Arginine 50,+ hemin 50,T8: Arginine 50 + hemin 100,T9: Arginin 50 + Fe EDTA 50,T10: Arginine 50 +Fe EDTA 100

Table 4: Variations on seed and oil yields and its components of two sesame cultivars.

Cultivars	Plant height (cm)	Height of first capsule (cm)	No. of capsules/ plant	Capsules weight (g)	Biological yield/plant (g)	Seed yield/ plant (g)	Seed yield (Kg/ feddan)	Oil %	Carbohyd %	Oil yield (Kg/feddan)
Shandwil-3	129.9	44.8	81.2	127.77	215.98	17.07	701.57	55.69	19.84	392.44
Giza-32	133.7	55.8	49.4	66.83	154.26	10.25	549.32	54.08	19.73	298.54
LSD 0.05	2.13	0.87	6.12	7.36	5.12	2.04	21.17	1.15	NS	4.33

Table 5: Effect of hemin, Fe-EDTA and Arginine and their interactions on seed and oil yields and its components of two sesame cultivars.

Treatments (mg/l)	Plant height (cm)	Height of first capsule (cm)	No. of capsules/ plant	Capsules weight (g)	Biological yield/plant (g)	Seed yield/ plant (g)	Seed yield (kg/feddan)	Oil %	Carbohyd. %	Oil yield (kg/fed.)
T1	104.0	59.5	19.5	25.5	50.0	5.5	342.25	52.40	16.23	179.51
T2	129.5	53.0	37.0	44.3	106.8	13.3	473.15	54.03	18.86	255.85
T3	133.0	47.0	61.0	72.9	123.1	13.4	612.11	53.93	19.55	329.94
T4	121.5	53.0	64.0	77.9	125.9	11.8	674.08	55.02	20.44	370.88
T5	138.5	46.0	61.5	113.6	179.0	17.1	636.92	55.13	20.86	352.11
T6	106.5	53.5	45.0	68.2	117.0	10.1	610.48	53.05	18.43	325.64
T7	133.5	49.0	74.0	123.9	250.4	12.7	613.13	55.77	20.37	342.78
T8	135.5	38.5	75.0	105.5	244.5	14.7	733.55	55.01	21.03	404.73
T9	161.0	53.5	108.5	189.8	341.0	17.8	806.43	56.56	20.88	456.51
T10	155.0	50.0	107.5	151.4	313.5	20.3	752.33	57.97	21.22	436.95
LSD 0.05	5.07	2.14	2.11	3.17	12.24	2.33	12.06	2.37	1.16	5.17

T1: Control,T2: Hemin 50 ,T3: Hemin100,T4: Fe EDTA 50,T5: Fe EDTA 100,T6: Arginine 50,T7: Arginine 50,+ hemin 50,T8: Arginine 50 + hemin 100,T9: Arginin 50 + Fe EDTA 50,T10: Arginine 50 +Fe EDTA 100

Table 6: Effect of hemin, Fe-EDETA and Arginine and their interactions on seed and oil yields and its components of two sesame cultivars under sandy soil conditions.

Cultivars	Treatments (mg/l)	Plant height (cm)	Height of first capsule (cm)	No. of capsules /plant	Capsules weight (g)	Biological yield /plant (g)	Seed yield/ plant (g)	Seed yield (Kg/ feddan)	Oil %	Carbohyd. %	Oil yield (kg /fed.)
Shandwil-3	**T1**	91.0	64.0	16.0	15.3	25.0	4.2	357.25	53.5	16.6	191.1
	T2	115.0	52.0	39.0	52.0	95.0	17.1	497.65	54.9	18.7	273.0
	T3	117.0	39.0	56.0	72.3	106.1	15.8	595.65	55.0	19.3	327.5
	T4	113.0	46.0	75.0	85.8	150.9	12.2	705.75	55.0	20.1	388.3
	T5	127.0	33.0	73.0	154.0	209.5	22.8	750.24	56.0	20.7	420.1
	T6	110.0	51.0	56.0	88.1	110.0	11.1	765.35	54.2	18.4	414.8
	T7	150.0	39.0	119.0	211.6	385.8	15.6	775.76	56.3	20.0	436.8
	T8	151.0	42.0	80.0	145.0	277.0	19.0	856.60	56.0	21.3	479.8
	T9	172.0	44.0	154.0	262.6	425.5	23.9	867.25	57.2	21.0	496.07
	T10	153.0	38.0	144.0	191.0	375.0	29.0	844.15	58.9	22.3	496.95
Giza-32	**T1**	117.0	55.0	23.0	35.7	75.0	6.9	327.25	51.3	15.9	167.88
	T2	144.0	54.0	35.0	36.6	118.6	9.4	448.65	53.2	19.0	238.68
	T3	149.0	55.0	66.0	73.4	140.0	11.0	628.57	52.9	19.8	332.39
	T4	130.0	60.0	53.0	70.0	101.0	11.4	642.40	55.0	20.8	353.45
	T5	150.0	59.0	50.0	73.5	148.5	11.4	523.60	54.3	21.1	284.16
	T6	103.0	56.0	34.0	48.2	124.0	9.1	455.60	51.9	18.5	236.46
	T7	117.0	59.0	29.0	36.2	115.0	9.7	450.50	55.2	20.7	248.81
	T8	120.0	35.0	70.0	66.0	212.0	10.3	610.50	54.0	20.8	329.67
	T9	150.0	63.0	63.0	117.0	256.5	11.7	745.60	55.9	20.8	416.94
	T10	157.0	62.0	71.0	111.7	252.0	11.6	660.50	57.1	20.1	376.95
LSD 0.05		5.2	3.1	3.3	3.1	7.3	1.1	12.18	0.4	0.2	7.55

T1: Control,T2: Hemin 50 ,T3: Hemin100,T4: Fe EDTA 50,T5: Fe EDTA 100,T6: Arginine 50,T7: Arginine 50,+ hemin 50,T8: Arginine 50 + hemin 100,T9: Arginin 50 + Fe EDTA 50,T10: Arginine 50 +Fe EDTA 100

improving vegetative growth (Table 2) that followed by active translocation of the photosynthetic products from source to sink in sesame varieties.

Treatment of sesame cultivars with arginine exhibited significant increments in all yield parameters. These results may be due to the stimulatory effects of arginine in increasing vegetative growth, metabolic products and their translocation to the produced grains of wheat plant (El Bassiouny et al. 2008). It can be suggested that amino acids could perform as components of salt tolerance mechanism and build up a favorable osmotic potential inside the cell in order to combat the effects of which replaced nitrate in the vacuoles (Sadak et al. 2012).

Iron is a vital element to plants; it is needed to biological redox systems (Asad and Rafique, 2000). It is an essential element for several enzymes which play vital roles in the physiological and biochemical processes of plants that reflected in consequences on yield and yield components. It serves as the cofactors constitutive of several enzymes participates in plant hormone synthesis and shares in several electron transfer reactions (Kerkeb and Connoly, 2006). Plants are subjected to varying differences in iron availability from the environment because of their immobility. Therefore, either starvation or excess amounts of this element are believed to generate oxidative stress (Abdel- Kader, 2007), which subsequently leads to several nutritional disorders that affect physiology of plant (Becker and Asch, 2005). Also, Sadak (2005) found that Fe-EDTA increased seed yield and chemical composition of Roselle seeds.

Variations in seed yield, yield components, oil yield and carbohydrate % under interaction effect between sesame cultivars and chemical constituents

Data presented in Table 6 show the effect of foliar application of hemin, Fe EDTA and arginine and their interactions on yield parameters of sesame plants grown under newly reclaimed sandy soil conditions. Data clearly show that, application of different treatments increased significantly yield and yield components such as plant height, number of capsules/plant, capsules weight, biological yield/plant, seed yield/plant and seed yield as compared with control plants. The maximum increases of the yield parameters were obtained by foliar application with 50 mg/l arginine + 50 mg/l Fe EDTA followed by 50 mg/l arginine + 100 mg/l Fe EDTA. Data in Table 6 also show that all used treatments led to significant increase in carbohydrates% and oil% of seed yield. Data also show that foliar application of hemin, iron and arginine and their interactions increased significantly carbohydrates%, oil% and oil yield as compared with the control. Moreover, the percentages of carbohydrate, oil and oil yield (Kg/feddan) were gradually increased with increasing concentrations of arginine and Fe EDTA. Shandawel-3 surpassed Giza-32 cultivar in all determined characters. The obtained results are in good agreement with those obtained by Abdel-Mawgoud et al. (2011); Ali and Hassan (2013). The overall improvement in plant yield because of application of amino acids might be due to providing with pleasure source of growing substances which form the constitutes of protein in the living tissues. Also, the positive effects of amino acids application might be brought as osmo-regulatory (Abdallah et al. 2015) since it is very soluble in water therefore increase the concentration of cellular osmotic components. Similar finding were obtained in response to amino acids application (Abdallah et al. 2015), who found that, total carbohydrate, and protein concentrations were increased in glutamic acid application on wheat plant. El-Bassiouny et al. (2008) concluded that, there is a close relationship between the effect of amino acids and the stimulated of the photosynthetic output (soluble sugars, polysaccharides and total carbohydrates) of wheat plant. These results might increase the efficiency of solar energy conversion which maximized the growth ability of wheat plant and consequently increased its productivity.

Watanabe et al. (2006) found that the yield of grape plant could be improved by ALA (precursor of hemin) which treatment at low concentration (30–300 mg/L). In addition, Xu et al. (2010b) revealed that, the foliar application of ALA with low concentrations increased growth, chemical composition and yield of kudzu plants. Iron deficiency is a widespread nutritional trouble in many crop plants, resulting in poor yields and decreased nutritional quality. Also, at limited Fe availability in the soil, the development of more root hairs can increase the absorption surface of the root and improves the affinity of Fe uptake system (Schmidt, 2003; Séguéla et al. 2008). Such regulation of Fe uptake at Fe deficiency might, at least in part, explain the increased number of lateral roots developed on cherry plum micro-plants grown on medium with $FeSO_4$. In addition, Pande et al. (2011) found that Fe supply of *Mentha spicata* L. showed the significant increase of oil yield. Mostafa et al. (2005) found that foliar treatment of Fe- EDTA increased significantly total carbohydrates, oil % and the weight of seed/plant of Roselle seeds. Moreover, Abdel–Shafy et al. (2001) observed that, Fe enhanced oil %, yield and quality of cotton seeds.

CONCLUSIONS

From the previous results it could be concluded that all treatments significantly increased the growth criteria, photosynthetic pigments and carbohydrate content, as well as yield and yield attributes (number of seeds/pod, seed yield/plant, biological and seed yields) as compared with the untreated plants. The most effective treatment was 50 mg/l Arg. + 100 mg/l Fe-EDTA and 50mg/l Arg. + 50 mg/l Fe-EDTA. Different treatments increased markedly total carbohydrates content, oil%, and oil yield of the yielded seeds compared with those of the untreated plants. Concerning the effect of varietal differences, data illustrates that, Shandawel-3 cultivar surpassed Giza-32 in all determined characters, except for plant height.

ACKNOWLEGEMENT

This work was supported and funded by National Research Centre through the project entitled: (Increasing Performance and Productivity of Flax and Sesame Crops under Newly Reclaimed Sandy Soil). Project No. (10120201), during the 10th research plan of projects strategy 2013-2016.

REFERENCES

Abd El–Monem, A.A. 2007. Polyamines as modulators of wheat growth, metabolism and reproductive development under high temperature stress. Ph.D. Thesis, Ain Shams Univ., Cairo, Egypt.

Abd El-Monem, A.A., El-Habbasha, S.F. & Hozayn, M. 2013. Mitigation Salinity Stress Effects on Barley *Hordeum vulgare* L. Growth, Yield and Some Physiological Aspects by Hemin. Journal of Applied Sciences Research, 93: 2411-2421.

Abdallah, M.M.S., El-Bassiouny, H.M.S., Bakry, A.B. & Sadak, M. Sh. 2015. Effect of *Arbuscular mycorrhiza* and Glutamic Acid on Growth, Yield, Some Chemical Composition and Nutritional Quality of Wheat Plant Grown in Newly Reclaimed Sandy Soil. RJPBCS 63: 1038-1054.

Abdel-Kader, D.Z.E.A. 2007. Role of nitric oxide on iron homeostasis, chlorophyll biosynthesis and antioxidants system in two wheat cultivars. Am. J. Plant Physiol., 2: 237-250.

Abdel–Shafy, N.A., El–Menshawi, M.E. & Girgis, E.A. 2001. Effect of some macro and micronutrients fertilization on cotton yield. Minufiya J. Agric. Res., 26: 673–687.

Abdel-Mawgoud, A.M.R., El-Bassiouny, A.M., Ghoname, A, & Abou-Hussein, S.D. 2011. Foliar Application of Amino Acids and Micronutrients Enhance Performance of Green Bean Crop under Newly Reclaimed Land Conditions. Australian Journal of Basic and Applied Sciences, 56: 51-55.

Abdullahi, R., Sheriff, H.H. & Lihan, S. 2013. Combine effect of bio-fertilizer and poultry manure on growth, nutrients uptake and microbial population associated with sesame *Sesamum indicum* L. in North-eastern Nigeria. Journal of Environmental Science, Toxicology and Food Technology, 5(5): 60-65.

Ali, E.F. & Hassan, F.A.S. 2013. Impact of foliar application of commercial amino acids nutrition on the growth and flowering of *Tagetes erecta* L. plant. J. Appl. Sci. Res., 9: 652-657.

A.O.A.C. 1990. Official Methods of Analysis. 15th Ed. Association of Official Analytical Chemists, Inc., Virginia: 770–771

Asad, A. & Rafique, R. 2000. Effect of zinc, copper, iron, manganese and boron on the yield of yield components of wheat crop in tehsil Peshawar. Pak. J. Biol. Sci., 3: 1615-1620.

Ashri, A., Roebbelen, G., Downey, R.K. & Ashri, A. 1989. Oil Crops of the World. McGraw- Hill, New York, pp: 375-387

Bashir, K. & Nishizawa, N.K. 2013. Iron Proteins: Plant iron transporters. In: Encyclopedia of

Metalloproteins Kretsinger RH, Uversky VN, Permyakov EA, eds., pp. 1015-1023, Springer, New York.

Bouchereau, A., Aziz, A., Larher, F. & Murting-Tanguy, J. 1999. Polyamines and development challenges recent development. Plant Sci., 140: 103-125.

Becker, M. & Asch, F. 2005. Iron toxicity in rice – conditions and management concepts. J. Plant Nutr. Soil. Sci., 168, 558–573.

Debnath, S., Moharana, R.L. & Balsu, A.K. 2007. Evaluation of sesame *Sesamum indicum* L. genotypes for its seed production potential as influenced by biofertilizer. Journal of Crop and Weed, 32: 33-36.

EL-Bassiouny, H.M.S., Khattab, H.K.I. & Sadak, M.Sh. 2005. Synergistic effect of GA3 and BA on growth, photosynthetic pigments, metabolites, phytohormone and fibre yield of Roselle plants. Egypt J. Biotechnol., 21: 13-31.

El–Bassiouny, H.M.S., Mostafa, H.A., El–Khawas, S.A., Hassanein, R.A., Khalil, S.I. & Abd El–Monem, A.A. 2008. Physiological responses of wheat plant to foliar treatments with arginine or putrescine. Aust. J. of Basic and Applied Sci., 24: 1390-1403.

El-Habbasha, S.F., Abd-El-Salam, M.S. & Kabesh, M.O. 2007. Response of two sesame varieties *Sesamum indicum* L. to partial replacement of chemical fertilization by bio-organic fertilizers. Research Journal of Agriculture and Biological Sciences, 36: 563-571.

Gomez, K.A. & Gomez, A.A. 1984. Statistical Procedures for Agricultural Research. New York: John Wiley and Sons Publication, pp: 460.

Granick, S. 1961. Magnesium protoporphyrin monoester and protoporphyrin monomethyl ester in chlorophyll biosynthesis. Journal of Biology and Chemistry, 236: 1168-1172.

Han, Y., Xuan, W., Yu, T., Fang, W.B., Lou, T.L., Gao, Y., Chen, X.Y., Xiao, X. & Shen, W.B. 2007 Exogenous hematin alleviates mercury-induced oxidative damage in the roots of *Medicago sativa*. J. Integr. Plant Biol., 49:1703–1713.

Herbert, D., Phipps, P.J. & Strange, R.E. 1971. Chemical Analysis of Microbial Cells. Methods in Microbiology, 5B: 209 -344.

Kao, C.H. 1994. Endogenous polyamine levels and dark induced senescence of detached corn leaves. Bot. Bull. Acad. Sinica, 351: 15 – 18.

Kerkeb, L. & Connoly, E. 2006. Iron transport and metabolism in plants. Genet. Eng., 27: 119-140.

Khalil, S.I., El Bassiouny, H.M.S., Hassanein, R.A., Mostafa, H.A.M., El–Khawas, S.A. & Abd El–Monem, A.A. 2009. Antioxidant defense system in heat shocked wheat plants previously treated with arginine or putrescine. Aust. J. of Basic and Applied Sci., 1517-1526.

Lichtenthaler, H.K. & Buschmann, C. 2001. Chlorophylls and Carotenoids: Measurement and Characterization by UV-VIS Spectroscopy. In: Wrolstad RE, Acree TE, An H, Decker EA, Penner MH, Reid DS, Schwartz SJ, Shoemaker CF, Sporns P eds Current protocols in food analytical chemistry CPFA. John Wiley and Sons, New York, pp F4.3.1–F4.3.8.

Liu, K.L., Xu, S., Xuan, W., Ling, T.F., Cao, Z.Y., Huang, B.K., Sun, Y.G., Fang, L., Liu, Z.Y., Zhao, N. & Shen, W.B. 2007. Carbon monoxide counteracts the inhibition of seed germination and alleviates oxidative damage caused by salt stress in *Oryza sativa*. Plant Sci., 172:544–555.

Mohamed, M.F., Abdallah, M.M.S., Khalifa, M., Ahmed, G.A. & Hozayn, M. 2015. Effect of Arginine and GA_3 on growth, yield, mineral nutrient content and chemical constituents of faba bean plants grown in sandy soil conditions. International Journal of ChemTech Research, 8(12): 187-195.

Marschner, H. 1995. Functions of Mineral Nutrients: Micronutrients: Iron. In: Mineral Nutrition of Higher plants 2nd ed. pp. 313-323, London, Academic Press.

Meloni, D.A., Oliva, M.A., Ruiz, H.A. & Martinez, C.A. 2001. Contribution of proline and inorganic solutes to osmotic adjustment in cotton under salt stress. Journal of Plant Nutrition, 24: 599-612 .

Mo, H. & Pua, E.C. 2002. Up – regulation of arginine decarboxylase gene expression and accumulation of polyamines in mustard *Brassica juncea* in response to stress. Physiol. Planta, 114: 439-449.

Mostafa, H.A.M., Hala M.S. El-Bassiouny, Khattab, H.K.I. & Sadak, M.Sh. 2005. Improving the Characteristics of Roselle Seeds as a New Source of Protein and Lipid by Gibberellin and Benzyladenine Application. Journal of Applied Sciences Research, 12: 161-167, Nassar, A.H., El–Tarabily, K.A. & Sivasithamparam, K. 2003. Growth promotion of bean *Phaseolus vulgaris* L. by a polyamine – producing isolate of *Streptomyces griseoluteus*. Plant Growth Regul. Kluwer Academic Publishers, Dordrecht, Netherlands, 402: 97-106.

Pande, P., Chand, S., Pandey, A. & Patra, D.D. 2011. Effect of sole and conjoint application of iron and manganese on herb yield, nutrient uptake, oil quality vis-à-vis their optimal level in spearmint *Mentha spicata* Linn. Emend. Nathh.cv. **'**Arka**'** Indian Journal of Products and Resources, 22 242-249.

Paschalidis, A.K. & Roubelakis–Angelakis, A.K. 2005. Sites and regulation of polyamine catabolism in the tobacco plant. Correlation with cell division/expansion, cell cycle progression and vascular development. Plant Physiol., 138: 2174-2184.

Rout, G.R. & Sahoo, S. 2015. Role of iron in plant growth and metabolism. Agricultural Science, 3:1-24.

Sadak, M. Sh., 2005. Physiological studies on the interaction effects of gibberellic acid and benzyladenine on Roselle *hibiscus sabdariffa* L. plant. PhD. Thesis Fac. of Sci. Ain Shams Univ., Egypt.

Sadak, M. Sh., Abd El-Monem, A.A., El-Bassiouny, H.M.S. & Badr, N.M. 2012. Physiological response of sunflower *Helianthus annuus* L. to exogenous arginine and putrescine treatments under salinity stress. Journal of Applied Sciences Research, 810: 4943-4957.

Samaranayake, P., Peiris, B.D. & Dssanayake, S. 2012. Effect of excessive ferrous Fe^{2+} on growth and iron content in rice *Oryza sativa*. Int. J. Agric. Biol., 14: 296-298.

Schmidt, W. 2003. Iron homeostasis in plants: Sensing and signaling pathways. Journal of Plant Nutrition 2610-11: 2211-2230. DOI: 10.1081/pln-120024276.

Séguéla, M., Briat, J-F, Vert, G. & Curie, C. 2008. Cytokinins negatively regulate the root iron uptake machinery in Arabidopsis through a growth-dependent pathway. The Plant Journal, 55: 289-300.

Singaravel, R., Govindasamy, R. & Balasubramanian, T.N. 1998. Influence of humic acid, nitrogen and *Azospirillum* on the yield and nutrient uptake by sesame. J. Indian Soc. Soil Sci., 461: 145-146.

Suja, K.P., Abraham, J.T., Thamizh, S.N., Jayalekshmy, A. & Arumughan, C. 2004. Antioxidant efficacy of sesame cake extract in vegetable oil protection. Food Chem. 84, 393 – 400.

Velikova, V., Yordanov, I.A. & Edreva, A. 2000. Oxidative stress and some antioxidant systems in acid rain treated bean plants. Protective role of exogenous polyamines. Plant Sci., 5: 59-66.

Vigani, G., Zocchi, G., Bashir, K., Philippar, K. & Briat, J.F. 2013. Signals from chloroplasts and mitochondria for iron homeostasis regulation. Trends Plant Sci., 18: 305-311.

Watanabe, K., Nishihara, E., Watanabe, S., Tanaka, T., Takahashi, K. & Takeuchi, Y 2006. Enhancement of growth and fruit maturity in 2-year-old grapevines cv. Delaware by 5-aminolevulinic acid. Plant Growth Regulation, 49: 35-42.

Wu, M.Z., Huang, J.J., Xu, S., Ling, T.F., Xie, Y.J. & Shen, W.B. 2010. Haem oxygenase delays programmed cell death in wheat aleurone layers by modulation of hydrogen peroxide metabolism. J. Exp. Bot. doi:10.1093/jxb/erq261

Xu, S., Sa, Z.S., Cao, Z.Y., Xuan, W., Huang, B.K., Ling, T.F., Hu, Q.Y. & Shen, W.B. 2006. Carbon monoxide alleviates wheat seed germination inhibition and counteracts lipid peroxidation mediated by salinity. J. Integr. Plant Biol., 48:1168–1176.

Xu, S., Zhang, B., Cao, Z.Y., Ling, T.F. & Shen, W.B. 2010a. Heme oxygenase is involved in cobalt chloride-induced lateral root development in tomato. Biometals. doi:10.1007/s10534-010-9386-1

Xu, F., Zhu, J., Cheng, S., Zhang, W. & Wang, Y. 2010b. Effect of 5-aminolevulinic acid on photosynthesis, yield, nutrition and medicinal values of kudzu *Pueraria phaseoloides* Tropical Grasslands., 44: 260-265.