Annals of Agric. Sci., Moshtohor **ISSN 1110-0419**
Vol. 60(4) (2022), 1239 – 1246 **https://assjm.journals.ekb.eg**

Improving Sunflower (*Helianthus annusl*) Growth and Productivity Using Cobalt Application

[1-2]Gowidan, M.K; [2]Nadia Gad; [1]Mohamed H.Abbas. and[1]Ihab, M.Farid;
1- Soils and Water Dep. Faculty of Agricultur, Banha University.
2- Plant nutrition Dep., National Research Centre Dokki, Egypt.

Abstract

A pot experiment was conducted for two successive seasons to evaluate the effect of cobalt on sunflower growth, yield and essential oil percent. Experiment was conducted at a cage house , National Research Centre , Dokki ,Giza .Egypt. Plastic pots 50 cm diameter of ten kg soil capacity were used. Sunflower seeds were sown at 7th and 9th March of during 2018 and 2019. Seedlings (at the third true leaf) were irrigated with cobalt, sulphate once, with different cobalt doses (7.5 , 10.0 , 12.5 , 15.0 , 17.5 , and 20.0 mgL^{-1}). All cobalt levels has a significant enhancing effect on plant growth, yield and essential oil contents. Cobalt at rate of 12.5 mgL^{-1} resulted the greatest effect. As cobalt level in plant media increased more than 12.5 mgL^{-1}, the promotive effect was reduced. All levels of cobalt increased contents of (N, P and K) as well as (Mn, Zn and Cu) in seeds. As cobalt increased in plant media, cobalt content in sunflower seeds increased ,wherease Fe content was decreased.

Key words: Cobalt, Sunflower, Yield, Oil production.

Introduction

Sunflower (***Helianthus annuus L.***) is one of the important oil crops worldwide **(Aly *et al*., 2021)**. It is ranked the 3rd in oil production after soybean and peanut (**Thavaprakash** *et al., **2003).*** Seeds of sunflower contains 39 to 46% oil **(The Arab league for Nutrition Industries; 2007)**. This oil is rich in omega-3 and omega-6 fatty acids, which makes it of cardiovascular and of heart health benefits **(Aly et al., 2021)**. In Egypt, this crop can be cultivated successfully in the newly reclaimed soils **(Hamza and Safina, 2015)** to lessen the gap of edible oil consumption, which accounted only for 5% of total oil demand **(Bulletin of Statistical, Cost Production and Net Return, 2019)**. One of the important approaches to increase its productivity is via supplying plants with cobalt, which catalyzes the formation of oil in plant seeds from glucose **(Watanabe, 2006**; and**Gad, 2010).**

Cobalt (Co) is a beneficial element for higher plants **(Young , 1983),** and has a positive effect in plant metabolism **(Akeel and Jahan, 2020)**. For example, its application enhanced chlorophyll synthesis and photosynthesis rate in peanuts **(Angelove et al., 1993)**, sugar beet growth and the sugar yield **(Baureto and kagawa, 2001)**. It also increases plant height, root dry weights, leaf area index, dry matter accumulation in shoot pats (**Waston** *et al.,* **2001)**, stimulates tomato and cucumber growth and enhances their fruit yields **(Lisnik and Toma, 2003).** Co improves maize growth and its content of pigments **(Jaleel et al., 2008).** It is essential for the synthesis of vitamin B_{12} which is needed for human and animal nutrition **(Tekin *et al*., 2019 and Osman et al., 2021)**. Enriching plants with Co may have dual benefits i.e. increase crop yield and improve human health **(Linhares et al., 2019)** the level of its application should be precise to avoid the negative impacts of of high doses of Co on plant growth **(Mahey et al., 2020)** and human health **(Banerjee et al., 2021)**. According to **Gad (2010)** spraying canola plants with 12.5 mg Co L^{-1} was enough to attain the highest increase in canola growth, seed yield, oil yield and quality. **Aziz *et al.*, (2013)** found that the highest growth of sweet basil was recorded when spraying plants with 15 mg Co L^{-1}. In other plants, comparable concentrations of cobalt enhanced plant growth and productivity. In this concern, the highest increases in growth of rosemary, its herb yield, nutritional status and chemical constituents was observed when spraying plants with 10mg Co L^{-1} **(Gad et al., 2014)**. tomato yield (**Holah** *et al.,* **2019)** and potato (**Gad and Ali, 2020).)**, The objective of this study is to evaluate the effect of different cobalt doses on sunflower productivity between edible oil production and consumption.

Materials and Methods:

Soil analysis:

Physical and chemical properties of surface soil samples (10-20cm) collected from Nubaria, Behaira, Governorate, Egypt as well as particle size distributions and soil moisture were determined as described by **Klute(1986)and page et al (1982).** Soil P^{H}, EC, cations and anions, organic matter, $CaCO_3$,total nitrogen and available P, K, Fe, Mn, Cu were run according to Black et al. (1982).Determinations of soluble, available and total cobalt were determined according to method described by **Cottenie et al. (1982).** The obtained data are shown in Table1

Table 1. Physical and chemical properties of soil of the experiment.

property	Value	property	Value
Soil pH*	8.5	**Total-N, mg kg^{-1}**	**151.0**
EC, dS m^{-1**}	1.7	**Avail-P, mg kg^{-1}**	**133.0**
CaCO3 content, g kg^{-1}	34.0	**Avail-K, mg kg^{-1}**	**44.9**
Organic matter content, g kg^{-1}	2.0	**Avail-Fe, mg kg^{-1}**	4.5
Saturation percentage	32	**Avail-Mn, mg kg^{-1}**	2.7
Particle size distribution		**Avail-Zn, mg kg^{-1}**	4.5
Sand	70.8	**Avail-Cu, mg kg^{-1}**	5.2
Silt	25.6	**Total-Co, mg kg^{-1}**	9.9
Clay	3.6	**Avail-Co, mg kg^{-1}**	4.9
Textural class	Sandy loam	**Soluble-Co, mg kg^{-1}**	0.35

Soil pH* was determined in 1:2.5 soil:water suspension while the EC** was determined in soil paste extract

The experimental design :-

A pot experiment was conducted in a cage house at the National Research Centre , Dokki , Giza , Egypt during two successive summer seasons of 2018 and 2019 to study the effect of cobalt application on sunflower growth and productivity of sunflower yield (*Helianthus annusl*). In this experiment, acid washed plastic pots with 50 cm in both diameter and depth were filled with soil (approximately 10 kg per pot) and were planted with sunflower seeds (*helianthus annoys*), on 7 th and 9 th of March at a rate of 6 seeds per pot and two transplants were retained in each pot. All pots were irrigated using tap water at moisture content of soil field capacity (based on the weight) and repeated every two days.

N,P,K were applied : 330 mg N kg^{-1} (as ammonium sulphate 205g N kg^{-1}) + 620mg P kg^{-1} (as calcium superphosphate 55 g P kg^{-1}) + 318 mg K kg^{-1} (as k-sulphate 480 g K kg^{-1}).

The experimental design was a randomized complete block .Treatments were seven as follows of 0.0 ,7.5 ,10.0, 12.5, 15.0 and 20 mg Co L^{-1}, respectively.

Statistical analysis:-

All data were subject to statistical analysis **(Snedecor and Cochran 1982)** .

Results and Discussions:-

Nutritional status

Nutrient contents in seeds were taken as indicators for the nutritional effect on plants. Application of Co increased its content in plant .Increases progressed with increasing applied Co as follows $C0_{20}>C0_{17.5}>Co_{15}>Co_{12.5}>Co_{10}>Co_{7.5}$ Contents of NPK as well as Mn and Zn followed a progressive increase as follows $C0_{20}>C0_{17.5}>Co_{15}>Co_{12.5}>Co_{10}>Co_{7.5}$.There was no effect on Fe content . High levels of applied cobalt may have induced formation of lateral roots which supply plants with water and nutrients besides being supports for the grown plants **(Hsu et al., 2013)**.Thus Co application smust have enhanced the transport of nutrients from soil **(Sahay et al., 2013; Jayakumar et al., 2008; Banerjee and Roychoudhury, 2021)**.

Table 2. Minerals composition in Sunflower seeds as affected by cobalt under different application levels (Means of two seasons)

Application level of Co mgL^{-1}	Macronutrients (%)			Micronutrients (mg L^{-1})				Cobalt (mg L^{-1})
	N	P	K	Mn	Zn	Cu	Fe	
control	1.17 d	0.66 f	1.72 e	30.27 c	31.8 a	57.67 a	140 a	0.89 g
7.5	1.22 cd	0.690 e	1.76 d	31.33 dc	32.4 cd	24.27 a	138 a	3.18 f
10	1.25 bc	0.72 d	1.93 c	32.23 b	33.4 bc	17.95 a	134 a	5.42 e
12.5	1.33 a	0.77 a	2.23 a	34.30 a	34.9 a	25.60 a	130 a	7.64 d
15	1.32 a	0.76 a	2.19 b	33.77 a	34.2 a	26.60 a	128 ab	9.24 c
17.5	1.30 ab	0.74 b	2.17 b	32.13 b	33.7 bc	29.17 a	126 ab	11.46 b
20	1.25 bc	0.72 d	1.95 c	31.43 d	32.7 cd	21.50 a	123 b	14.37 a

Similar letters indicate no significant difference among treatments

Application of Co up to 12.5 mg L^{-1}, stimulated nutrient uptakes must have contributed to the increase in plant growth and productivity. Such increases were more noticeable with increasing the concentration of Co. Oil productivity increased by 1.33 folds owing to applying the 12.5 mg Co L^{-1} . As applied cobalt increased, iron decreased, indicating an antagonistic relationship.

3.2. Vegetative growth parameters:-

Data presented in Fig. 1 show that the application of Co increased growth parameters such as plant height , leaves number per plant as well as fresh and dry weight of both shoots and roots plant . Cobalt at a rate of12.5 mgL^{-1} , resulted the highest effect. Application above 12.5 mg L^{-1} caused no positive effect.

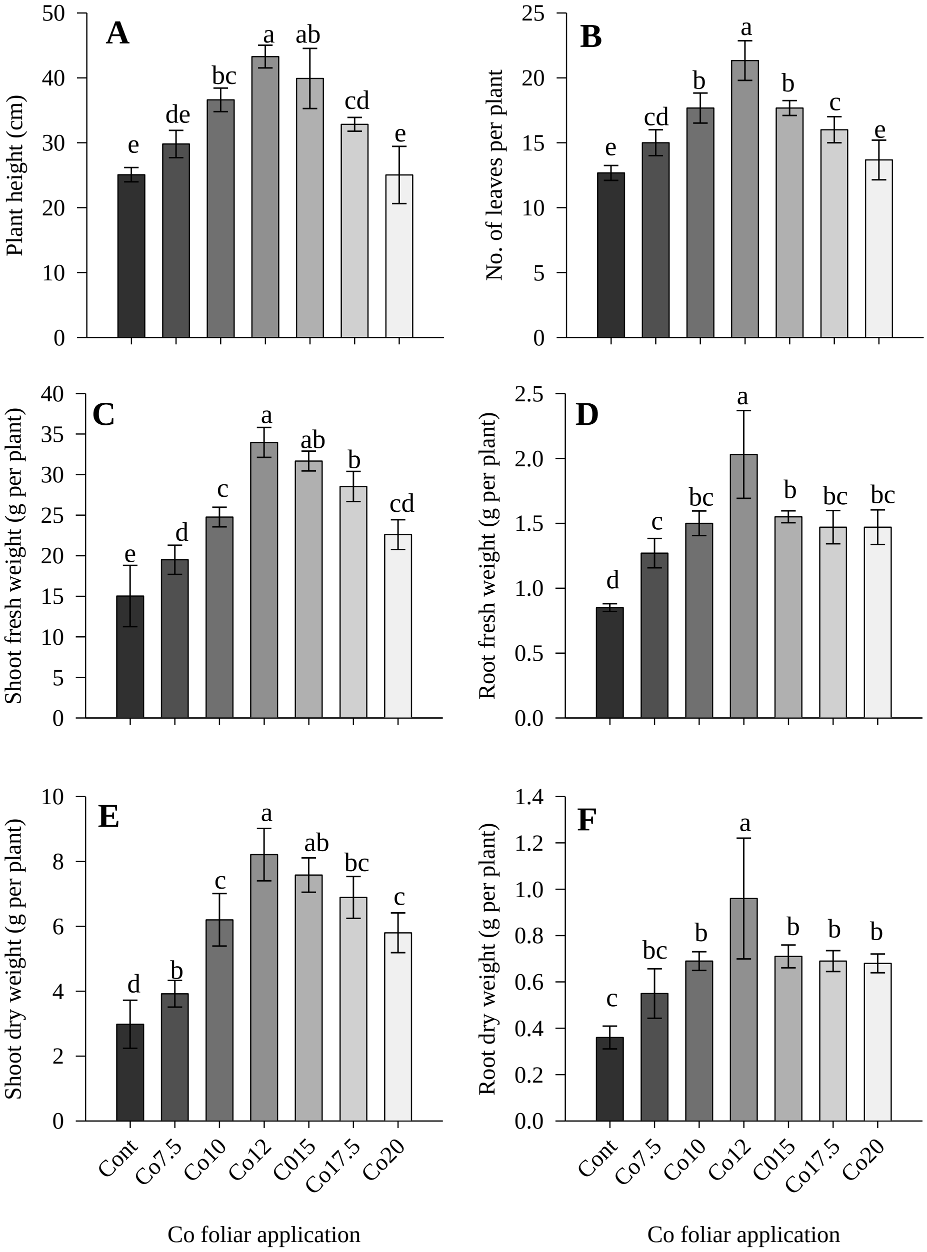

Fig. 1. Vegetative growth parameters of sunflower plants as affected by application of cobalt. (means of two seasons) .

3.3. Yield characteristics :-

Data in Fig. 2 reveal that ,cobalt increased seed yield per plant and improved the quality traits of this yield (head diameter, head weight, 100-seed weight and the oil percentage in seeds). Cobalt at a rate of 12.5 mg/L^{-1} resulted the greatest values .Co simulative effect was noticed onsoybean **(Jayakumar et al., 2009)**, chickpea **(Rod et al., 2019)**, sugarcane **(Silva et al., 2022)** and cucumber **(Brengi et al., 2022).** This may be due to mediating polyamine metabolism **(Javed and Anis., 2015)**. **Helmy and Gad (2002)** found that parsley plants with cobalt at a rate of 12.5 mg L^{-1} recorded the highest increase of essential oil .

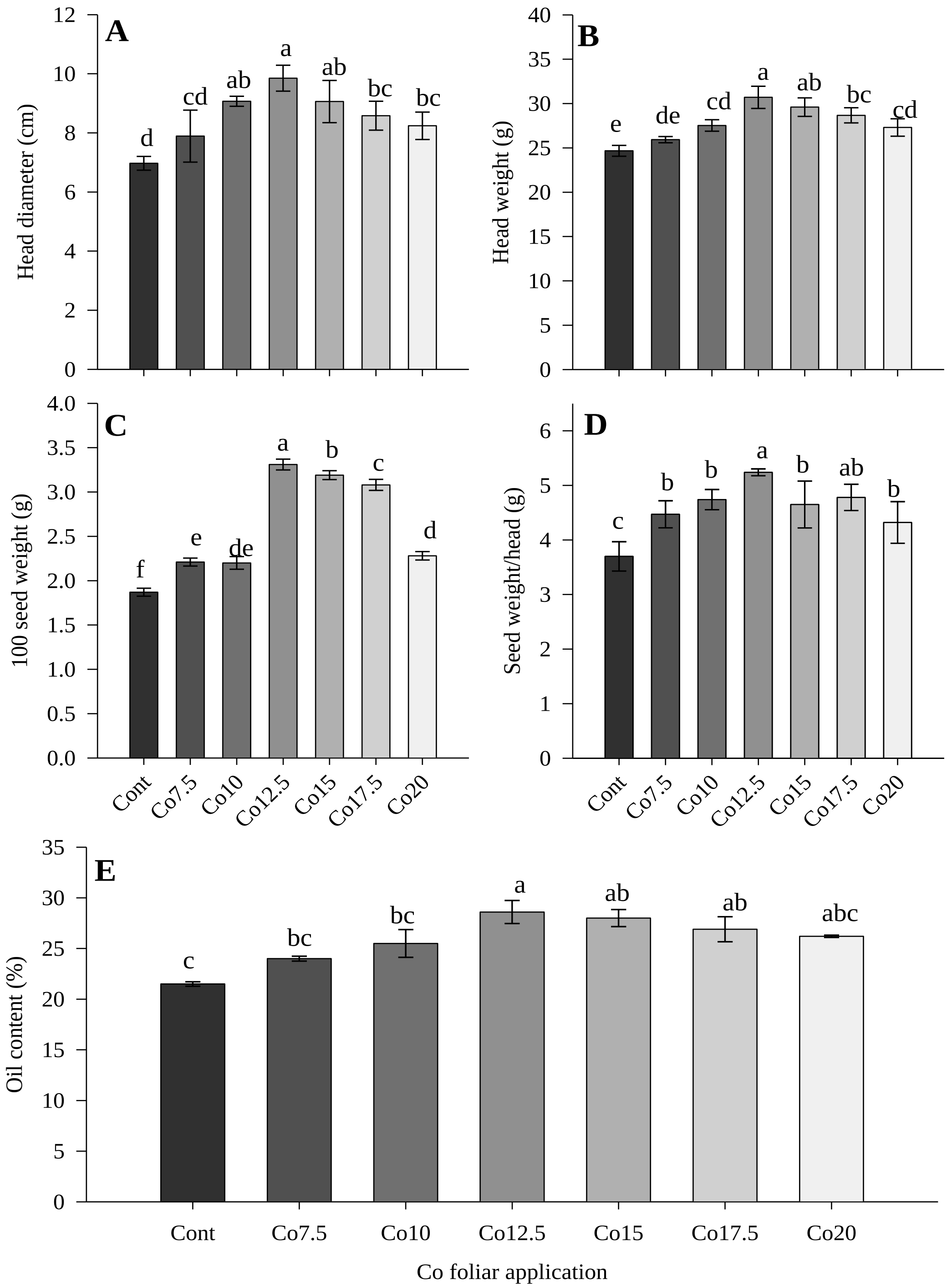

Fig. 2. Sunflower yield parameters as affected by application of cobalt. (Means of two seasons).

3.4. Pearson correlations

Results obtained in Table 3 indicate that all the investigated growth parameters (plant height, number of leaves per plant, the fresh and dry weights of both roots and shoots) and yield components (head diameter, its weight, 100 seed weight, seed weight per head and the oil percentage in seeds) were significantly correlated with the status of N, P, K, Mn, Zn. Correlations between with either Co or Fe and the above mentioned growth parameters and yield components were not significant. Yield components of sunflower were correlated significantly with the plant growth parameters.Increasing cobalt level more than 12.5 mgL^{-1}, the beneficial effect was decreased.

Table 3. Correlation coefficients between different growth parameters of sunflower plants, yield components and seed nutritional status as affected by Cobalt applications (Means of two seasons).

	Plant growth parameters						Yield and its components					Nutritional status in seeds						
	Plant height (Cm)	No of leaves per plant	Shoot fresh weight (g)	Shoot dry weight (g/plant)	Root fresh weight	Root dry weight (g)	Head diameter (Cm)	Head weight (g)	100 seed weight (g)	Seed weight per head (g)	Oil content (%)	N (%)	P (%)	K (%)	Mn Mg/L	Zn Mg/L	Cu Mg/L	Fe
Plant growth parameters																		
Plant height																		.
No of leaves per plant	0.881**																	
Shoot fresh weight	0.849**	0.829**																
Shoot dry weight	0.794**	0.784**	0.970**															
Root fresh weight	0.757**	0.816**	0.856**	0.874**														
Root dry weight	0.708**	0.796**	0.837**	0.850**	0.966**													
Yield and its components																		
Head diameter	0.853**	0.819**	0.875**	0.882**	0.897**	0.851**												
Head weight	0.839**	0.785**	0.958**	0.956**	0.912**	0.881**	0.900**											
100 seed weight	0.761**	0.714**	0.920**	0.873**	0.748**	0.719**	0.722**	0.904**										
Seed weight per head	0.668**	0.832**	0.710**	0.692**	0.698**	0.634**	0.641**	0.656**	0.672**									
Oil content in seeds	0.541*	0.503*	0.623**	0.623**	.446*	0.495*	0.543*	0.603**	0.593**	0.638**								
Nutritional status in seeds																		
N	0.799**	0.734**	0.942**	0.919**	.849**	0.834**	0.898**	0.961**	0.875**	0.638**	0.572**							
P	0.805**	0.775**	0.962**	0.957**	.840**	0.800**	0.843**	0.945**	0.931**	0.616**	0.744**	0.903**						
K	0.729**	0.714**	0.944**	0.934**	.780**	0.765**	0.766**	0.926**	0.965**	0.645**	0.685**	0.892**	0.971**					
Mn	0.913**	0.876**	0.937**	0.903**	.848**	0.841**	0.884**	0.925**	0.846**	0.559**	0.667**	0.898**	0.895**	0.848**				
Zn	0.838**	0.779**	0.896**	0.856**	.785**	0.812**	0.831**	0.884**	0.804**	0.749**	0.576**	0.883**	0.842**	0.819**	0.898**			
Cu	0-.233	-0.244	-0.392	-0.391	-.385	-0.357	-0.348	-0.325	-0.286	-0.185	-0.268	-0.369	-0.361	-0.312	-0.310	-0.261		
Fe	0.119	0.114	-0.027	-0.058	-.063	-0.112	0.036	-0.029	-0.012	0.129	-0.056	-0.012	-0.108	-0.122	-0.016	-0.002	0.126	

* Correlation is significant at 0.05 level (2-tailed)
** Correlation is significant at 0.01 level (2-tailed

Conclusion

Application of cobalt is promising in the newly reclaimed soils .It had a beneficial effect on sunflower growth, seed yield as well as oil content in seeds.

References

Akeel, A.and Jahan, A. (2020). Role of cobalt in Plants: Its Stress and Alleviation. In: Naeem, M., Ansari, A., Gill, S. (eds) Contaminants in Agriculture. Springer, Cham. https://doi.org/10.1007/978-3-030-41552-5_17

ALNI. (2007) The Sixth International Arab Conference for Oils and Fats and the Fifth International Arab Fair for the nutrition industries for packing and wrapping – Damascus –Syria-10-14 Jul 2007.

Aly, A.A., Zaky, E.A., Elhabeby, B.S., Alessa, H., Hameed, A.M., Aljohani, M., Nassan, M.A., Kadasah, S., Mohamed, E.S.,and Alghamdi, A.A.A. (2021) Effect of thyme addition on some chemical and biological properties of sunflower oil, Arabian Journal of Chemistry, 14 (11),103411, https://doi.org/10.1016/j.arabjc.2021.103411.

Angelove, M.; T. Tsonev; K. Dobrinova; V. Velikova and T.Stoynaova (1993). Changes in some photosynthetic parameters in pea plants after treatment with cobalt. Phytosynthetica. 28: 289-

Aziz,E., Gad,N., Lyazzat K. Bekboyeva and Misni Surif (2013). Role of cobalt in sweet Basil (Ocimum basilicum L.) plants. A- Herb yield, essential oil content and its composition. Middle East Journal of Scientific Research 14(1):23-2. Doi: 10.5829/idosi.mejsr.2013.14.1.7287

Banerjee, A., Roychoudhury, A. (2021) Chapter 18 - Beneficial aspects of cobalt uptake in plants exposed to abiotic stresses, In: Frontiers in Plant-Soil Interaction (Aftab, T., Hakeem, K.R., eds), Academic Press, pp 523-529**,** https://doi.org/10.1016/B978-0-323-90943-3.00012-2.

Black, C.A., D.D. Evans, L.E. Ensminger, G.L. White and F.E. Clarck, (1982). 'Methods of Soil Analysis', Part 2. Agron. Inc. Madison Wise.

Blackmore, A.D., T.D. Davis, Jolly and R.H. Walser, (1972). Methods of Chemical Analysis of Soils. Newzealand. Soil Dureau.P A2.1, Dep. No. 10.

Boureto, A. E. and Kagawa, J. N. (2001). Effect of cobalt on suger beet growth and mineral content. Revistra Brasileira-Sementes. 18: 63.

Brengi, S.H., Khedr, A.E.M.,and Abouelsaad, I.A. (2022) Effect of melatonin or cobalt on growth, yield and physiological responses of cucumber (Cucumis sativus L.) plants under salt stress, Journal of the Saudi Society of Agricultural Sciences, 21 (1), 51-60, https://doi.org/10.1016/j.jssas.2021.06.012.

Bulletin of Statistical Cost Production and Net Return (2019). Winter Field Crops and Vegetables and Fruit, Agric. Statistics and Econ. Sector, Minist. Egypt. Agric. and Land Reclamation, Part (1).

Cottenie, A., M. Verloo, L. Kiekens; G. Velgh and R. Camerlynck, (1982). *Chemical* analysis of plant and soil. Chemical Analysis of Plants and Soils. PP 44-45. State Univ. Ghent Belgium.

Gad, N. and Fekry Ali, M.E. (2020): Influence of cobalt on potato (Solanum tuberosum) productivity. International Journal of Plant Archives 20(1), 1405-1408

Gad,N. (2010). Improving quantity and quality of canola oil yield through cobalt nutrition. Agriculture and Biological J. of North America. 1(5): 1090-1097, doi:10.5251/abjna.2010.1.5.1090.1097

Hamza, M.,and Safina, S. (2015). Performance of sunflower cultivated in sandy soils at a wide range of planting dates in Egypt. *Journal of Plant Production*, 6(6), 853-867. doi: 10.21608/jpp.2015.49782

Helmy, L.M. and Gad, N. (2002). Effect of cobalt fertilization on the yield, quality the essential oil composition of parsley leaves. Arab Univ. J. Agric. Sci., Ain Shams Univ., Cairo, 10 (3): 779-802.

Holah, Sh.Sh,, Abou Zeid, S.T.,and Gad, N., Abbas. M.M.(2019): Response of tomato (*Lycopersicum esculentum*) to cobalt supplement. Plant Archives 19(1), 81

Hsu, Y.Y., Chao, Y.-Y.,and Kao, C.H. (2013) Cobalt chloride-induced lateral root formation in rice: The role of heme oxygenase, Journal of Plant Physiology, 170 (12), 1075-1081, https://doi.org/10.1016/j.jplph.2013.03.004. https://doi.org/10.1016/B978-0-12-817955-0.00010-7.

Javed, S.B., and Anis, M. (2015) Cobalt induced augmentation of in vitro morphogenic potential in *Erythrina variegata* L.: a multipurpose tree legume. *Plant Cell Tiss Organ Cult* **120,** 463–474 (2015). https://doi.org/10.1007/s11240-014-0613-2

Jayakumar K., C. Abdul Jaleel, M.M. Azooz, P. Vijayarengan, M. Gomathinayagam and R. Panneerselvam (2009). Effect of different concentrations of cobalt on morphological parameters and yield components of soybean. Global Journal of Molecular Sciences 4 (1) 10-14.

Jayakumar, K.; C. Abdul Jaleel and M.M. Azooz (2008). Mineral Constituent Variations under Cobalt Treatment in *Vigna mungo* (*L.*) Hepper. Global Journal of Molecular Sciences. 3 (1) 32-34.

Linhares, D., Pimentel, A., Borges, C., Cruz, J.V., Garcia, P.,and Rodrigues, A. d.S. (2019) Cobalt distribution in the soils of São Miguel Island (Azores): From volcanoes to health effects, Science of The Total Environment, 684, 715-721, https://doi.org/10.1016/j.scitotenv.2019.05.359.

Lisnik, S. S. and Toma, S. I. (2003). Regulation of adaptive responses

Mahey, S., Kumar, R., Sharma, M. *et al.* (2020) A critical review on toxicity of cobalt and its bioremediation strategies. *SN Appl. Sci.* **2,** 1279. https://doi.org/10.1007/s42452-020-3020-9

Nadia Gad; Abd El-Moez; Eman E. Aziz, Lyazzat Bckbyeva; Idres Hamad At itaalla and Misni Surif (2014). Influence of cobalt on spybean growth and production under different levels of nitrogen.Research Article CODEN (USA): IJPLCP.

Osman, D., Cooke, A., Young, T.R., Deery, E., Robinson, N.J., and Warren, M.J. (2021) The requirement for cobalt in vitamin B12: A paradigm for protein metalation, Biochimica et Biophysica Acta (BBA) - Molecular Cell Research, 1868 (1), 118896, https://doi.org/10.1016/j.bbamcr.2020.118896.

Rod, N.K., Gudadhe, N.N., Karmakar, N., Mehta, P.V.,and Narwade, A.V., (2019) Cobalt chloride enhances crop duration, increases production, and productivity of chickpea, Journal of Plant Nutrition, 42:1, 40-57, DOI: 10.1080/01904167.2018.1544258

Sahay, N, Singh, .P.,and Sharma, V.K. (2013) Effect of cobalt and potassium application growth, yield and nutrient uptake in lentil (Lens culinaris L.). Legume Research.2013.(36):259-262

Silva, D.P., Johnson, R.M. & Crusciol, C.A.C. (2022) The effects of cobalt on sugarcane growth and development in plant cane and two ratoon crops. *Sugar Tech* (2022). https://doi.org/10.1007/s12355-022-01108-4

Snedecor, G. W.,and Cochran, W.G. (1982). Statistical methods. 7th Edition Iowa State Univ. Press. Ames. Iowa, USA.

Tekin, Z., Erarpat, S., Şahin, A., Chormey, D.S.,and Bakırdere, S. (2019) Determination of Vitamin B12 and cobalt in egg yolk using vortex assisted switchable solvent based liquid phase microextraction prior to slotted quartz tube flame atomic absorption spectrometry, Food Chemistry, 286, 500-505, https://doi.org/10.1016/j.foodchem.2019.02.036.

Thavaprakash, N., G. Senthilkumar, S. D. Sivakumar and M. Raju (2003) Photosynthetic attributes and seed yield of sunflower (Helianthus annuus L.) as influenced by different levels and ratios of nitrogen and phosphorus fertilizers, Acta Agronomica Hungarica, 51(2):149-155.

Young, S.R., (1983). Recent Advances of Cobalt Inhuman Nutrition. Victoria M.C. Canada. Micronutrients News, pp: 313.

تحسين نمو وانتاجية عباد الشمس باستخدام الكوبلت

جويدان محمد الكردى[1-2]، نادية جاد الرب[2-]، محمد حسن حمزه[1-]، ايهاب محمد فريد[1-].
1- قسم الأراضي والمياه – كلية الزراعة جامعة بنها – مصر
2 – قسم تغذية النبات – المركز القومي للبحوث – الدقى – مصر

أجريت تجربتان أصص لتقييم تأثير الكوبلت على نمو محصول عباد الشمس والنسبة المئوية للزيوت الطيارة في بذرة عباد الشمس .
تم زراعة بذور عباد الشمس في يوم 7 ، 9 مارس من الموسمين 2018 ، 2019 . ، وتم رى الشتلات ذات الثلاثة أوراق حقيقية بالكوبلت مرة واحدة بالتركيزات :
صفر (كنترول) ، 7.5 ، 10.0 ، 12.5 ، 15.0 ، 17.5 و 20.0 ملجم/ لتر.
والنتائج المتحصل عليها أوضحت الآتي : -

- كل تركيزات الكوبلت تحت الدراسة أدت إلى زيادة معنوية في نمو محصول البذور والنسبة المئوية للزيت بالمقارنة بالكنترول .
- الكوبلت بالتركيز 12.5 ملليجم/لتر أعطى أفضل النتائج .
- زيادة تركيز الكوبلت في بيئة نمو النباتات عن 12.5 ملجم/لتر أدى إلى نقص التأثير المفيد للكوبلت.. لكنها ظلت أقوى من النباتات.
- كل تركيزات الكوبلت أدت إلى زيادة المحتوى المعدنى لكل من العناصر الكبرى (N, P, k) والعناصر الصغرى (Mn , Zn , Cu) بالمقارنة بالكنترول .
- كلما زاد تركيز الكوبلت في بيئة نمو النباتات يقل امتصاص الحديد لوجود علاقة تنافسية بينهما .

الكلمات الدالة : الكوبت – عباد الشمس – المحصول – البذور والزيت – العناصر الغذائية (N, P, K, Fe, Cu,Mn,Zn)