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EFFICIENCY OF APPLIED RATES AND METHODS OF COBALT ON GROWTH, YIELD AND ELEMENTAL COMPOSITION OF PEANUT PLANTS GROWN ON A SANDY SOIL

BY

Nasef, M.A.*; Abd El-Hameed, A.M.*; Salem, H.M. and Amal F. Abd El-Hamide***

* Plant Nutrition Department, Soil, Water & Environment Research Institute, Agriculture Research Center, Giza, Egypt.

** Soils Department, Faculty of Agriculture, Moshtohor, Zagazig University (Banha Branch).

ABSTRACT

A field experiment was carried out at Ismailia Agriculture Station to study efficiency of the applied rates and methods of cobalt on growth, yield and elemental composition of peanut plants grown on a sandy soil under sprinkler irrigation system.

Results showed that the growth and yield components of peanut increased progressively and significant with increasing the applied Co level to the high rates of (4 kg fed^{-1}, 250 L of 1 g L^{-1} fed^{-1} and 0.02 g kg^{-1} seed for surface, foliar and coating application, respectively) as well as with an inversely affected the growth parameter, which their values remained significantly higher than the corresponding ones for the control treatment. It is evident that soil application of Co generally, showed a superiority as compared to the other two methods, foliar and coating applications. For the most of investigated plant parameters. Also, it is quite to mention that Co at either any applied rate or method could achieved significantly increases in peanut uptake of N, P, K, Fe, Mn, Zn, Cu and Co. In general, Co at the minimum rate was of more pronounced effect on peanut uptake for most the studied element, except of N and K, where the opposite was true.

INTRODUCTION

Mineral elements which either stimulate growth or those essential only for certain plant species, or under special condition; are usually defined as beneficial elements. Cobalt is considered one of these elements, although there is no evidence that cobalt base any direct role in the metabolism of higher plants (Anter and Gad, 2001). Importance of Co for higher plants has not yet been established but reports showed that small amount of Co can increase plant growth (Dahdoh and Moussa, 2000). Cobalt is thought to be a regulatory element affecting some plant process such as N- fixation and vitamin B_{12} accumulations (Ahmed and Evans, 1959).

The present study is a trial towards throwing some light on the effect of cobalt, both level and method of application, on some yield parameters and elemental composition of peanut plants grown on a sandy soil under sprinkler irrigation system.

MATERIALS AND METHODES

The present study was carried out at Ismailia Agriculture Station, Egypt, during the summer season of 2002 where peanut plants (*Arachis hypogaea* L.,) cv Giza 5 was grown on a sandy soil. Some physical and chemical characteristics of the experimental soil were determined according to the standard procedures described by Page *et al.*, (1982) and Black (1982) and presented Table (1).

Table (1): Some chemical and physical properties of the investigated soil.

Properties	Value	Properties	Value
Sand%	96.00	Available N (mg kg^{-1})	12.00
Silt%	2.00	Available P (mg kg^{-1})	4.00
Clay%	2.00	Available K (mg kg^{-1})	34.00
Textural class	Sandy	Available Fe (mg kg^{-1})	3.01
pH (1:2.5 soil suspension)	7.80	Available Mn(mg kg^{-1})	1.40
EC dSm^{-1}	1.62	Available Zn (mg kg^{-1})	0.61
Organic matter%	0.23	Available Cu (mg kg^{-1})	0.5
$CaCO_3$%	0.33	Available Co (mg kg^{-1})	0.59

The experiment was laid out in a factorial randomized complete block (RCB) design, with three replicates.

Methods of Cobalt application:

1- Surface application, where cobalt sulphate at two rates of 2 and 4 kg Co fed^{-1} was mixed with saw dust as glow material, then added to soil.
2- Foliar application, where cobalt sulphate at two rates of 0.5 and 1.0 gL^{-1} was added as foliar application to crop after 30 and 51 days of cultivation, with a volume of 250 L fed^{-1}.
3- Coating of seeds, where cobalt sulphate at rates of 0.01 and 0.02 g kg^{-1} seeds was mixed with glow material and added to the seeds.

The combinations between methods and rates resulted in 6 treatments and replicated 3 times. Each plot area was 3X4 m^2. All plots were inoculated with Rhizobia and received 50 kg K_2O fed^{-1} as potassium sulphate and 30 kg P_2O_5 fed^{-1} as superphosphate before cultivation, besides, N at the rate of 40 kg N fed^{-1} (as recommended) was added in a form of ammonium sulphate at two equal portions after 1 and 2 months of cultivation. At end of the experiment, the plants were harvested and the yield of seeds was recorded. The seeds were ground and wet digested with a mixture of H_2SO_4 and $HClO_2$ acids.

Nitrogen was determined using micro Kjeldahl, P was determined with ammonium molybdate and ascorbic acid (Watanable and Olsen, 1965) and K was determined by using Flame- Photometrically. Fe, Mn, Zn, Cu and Co were determined using Atomic Absorption Spectrophotometer, (Perkin Elmer 3110). All data were statistically analyzed according to Gomez and Gomez (1984).

REULTS AND DISCUSSION

Plant growth and yield components:

Data in Table (2) reveal that the applied and rates of Co showed a significantly affected for all peanut plant growth and yield parameters, except for seed yield, i.e., forage yield, seed yield, total yield, weight of 100 seeds, pods weight per feddan or shilling percentage. However, it could be noticed that Co applied as soil application method seemed to be of the highest effect on forage yield, total yield and 100 seed weight. Further more, coating method was more superior than the other two methods of Co application in both cases for shilling percentage and pods weight. In this connection, it was found that foliar application method came in the second order upon taking shilling percentage into account, whereas soil application method occupied this order upon taking pods weight into account. Soil application method was of the least effect on shilling percentage, whereas foliar application method was of the least effect on pods weight. Dealing with the applied rates of Co, it was noticed that application of Co at its used two rates significantly affected forage yield, seed yield, total yield, weight of 100 seed, pods weight and shilling percentage. However, the lower rate of Co resulted in significant increase in forage yield, weight of 100 seed, pods weight and shilling percentage versus significant decrease in seed yield as compared with the corresponding values achieved by the higher rate of Co. Such increases might be attributed to importance of cobalt for symbiotic N-fixation which, in turn, resulted in higher growth. Shiv Raj (1987) reported that treating peanut with 500 μg Co kg^{-1} increased all components of yield. Also, it was found that groundnut essd treated with cobalt nitrate at rate of 500 mg/kg seed followed by 2 foliar sprays before and after flowering (500 mg/l water) increased plant height, leaf number, total dry matter, pod yield and shilling percentage. Walser *et al.* (1996) found that Co application (2-7 kg Co ha^{-1}) increased tomato leaf number as well as the number of carbohydrates, surface of leaf area and the rate of photosynthesis. The increase in growth parameters was reported also by Dahdoh and Moussa (2000) who found that yield of both broad bean and peanut increased due to application of Co at a rate of 0.125%. Likewise, Youssef *et al.* (2001) found that application of Co at a rate up to 60 μg g^{-1} increased significantly fresh and dry weight of shoots and roots of tomato plant. Unlike the lower rate of applied Co, the higher one, Co at the higher rate diminished most of the growth parameters as compared with the lower rate of the applied Co. These findings are in agreement with those of Youssef *et al.* (2001) who reported that, increasing the rate of the applied Co caused remarkable reduction in both shoots and roots of tomato plants. Such reduction in the yield components may considered as an indication to a potential toxicity due to Co.

Table (2): Yield components of peanut plant as affected by methods and rates of cobalt application.

Method of cobalt addition	Straw yield (Kg/fed)			Seed yield (Kg/fed)			100 – grain weight (g)			Pods weight (kg/fed)			Shilling percentage		
Control	1464.90			594.30			62.87			897.5			66.22		
	Co I	Co II	Mean (A)	Co I	Co II	Mean (A)	Co I	Co II	Mean (A)	Co I	Co II	Mean (A)	Co I	Co II	Mean (A)
(I) Soil application	2033.6	1769.1	1901.3	876.7	700.8	788.8	80.3	72.7	76.5	1348.3	1028.7	1188.5	65.0	68.1	66.6
(II) Foliar	1894.6	1700.7	1797.7	870.1	686.7	778.4	76.6	66.8	71.7	1251.7	1008.4	1130.05	69.5	68.0	68.8
(III) Coating	1876.7	1831.4	1854.0	851.7	863.4	857.6	75.7	74.7	75.2	1244.3	1180.1	1212.2	68.4	73.1	70.75
Mean(B)	1935.0	1767.0	-	866.1	750.3	-	77.5	71.4	-	1281.43	1072.4	-	67.6	69.9	-
$L.S.D_{0.05}$	A= 40.33 B= 32.94 AXB= 57.04			A=NS B=73.11 AXB=NS			A= 0.64 B= 0.52 AXB= 0.91			A= 50.02 B= 40.85 AXB= 70.75			A= 0.70 B= 0.57 AXB= 1.01		

(I): Co I = 2Kg Co fed^{-1} (II): Co I = 0.5g Co / liter. (III): Co I= 0.01 g / Kg seeds
Co II = 4Kg Co fed Co II = 1.0g Co / liter. Co II = 0.02 g / Kg seeds.

The interaction effect between the applied methods and rates of Co seemed to be significant on forage yield, 100 seeds weight, pods weight and shilling percentage. On the other hand, the interaction effect on seed yield was insignificant.

Elemental composition:

Data present in Table (3) show that both applied methods and rates of Co resulted in significant increases for N, P, and K uptake by both seeds and forage as compared with the control treatment. Such a finding might be attributed to a direct stimulating effect of Co on the symbiotic fixation of N. Considering values of N uptake by seeds, it seemed that the soil application method was of the highest effect in this concern, foliar application method come in the second order, whereas the coating method was of the least pronounced effect. Moreover, significant difference was detected between soil application method and each of the foliar and coating applications. Also, a significant difference could be detected between coating method and each of the foliar and soil applications.

The aforementioned order of the applied methods was not the same in case of N uptake values by forage. The coating method showed the highest effect followed by the foliar and soil applications. Furthermore, significant differences could be achieved between soil application method and each of the foliar and coating applications. However, the relatively low uptake of N by forage of the plants received soil and foliar Co applications as compared with the coating method is probably attributed to the easily N translocated and accumulated in seeds (Table 3). Youssef *et al.* (2001) found similar results on N content in tomato seedlings. Considering P and K uptake by peanut forage, data in Table 3 show that both the applied method and rate of Co could be resulted in a significant effect on K uptake by forage and seeds. On the other hand, the applied methods of Co showed in significant effect on P uptake by seeds or forage. However, it could be observed that increasing the rate of the applied Co although was associated with a decrease in P uptake by seeds and forage yet these it was still significantly higher than the control treatment. Unlike N, P and K uptake by seeds and forage increased significantly due to raising the applied rates of Co from CoI to CoII.

The applied method of Co seemed to be of in significant effect on P uptake by peanut forage or seeds. Also, in significant differences could be found among P uptake due to changing method of applying Co. The interaction effect between the applied methods rates of Co seemed to be insignificant for N uptake by forage or seeds. However, such an interaction affected significantly values of P and K uptake by both seeds and forage, but it did not affected significantly values of P uptake by forage.

Uptake patterns of all the micronutrients under study (Table 4) as well as Co seemed to be identical i.e. rates and methods of applied Co resulted in significant increases in uptake values of Fe, Mn, Zn, Cu and Co by forage and seeds as compared with the corresponding uptake ones in the control treatment. Moreover, increasing the rate of applied Co was associated with significant decrease in values of Fe, Mn, Zn, Cu and Co uptake although these values remained significantly higher than the corresponding ones of the control treatment. The effect of applied Co on stimulating N fixation and hence more plant growth may account for the higher uptake values of the considered nutrients (i.e. Fe, Mn, Zn and Cu) on one hand, the applied Co may account for its higher uptake values on the other one. These results stand in well agreement with those reported by Youssef *et al.* (2001) who attributed the effect of Co on increasing plant content of studied elements to the Co stimulating effect on growth, since Co is involved in co-enzyme and hence is essential for several enzymatic reaction.

Table (3): N,P and K uptake values (Kg/fed) by seeds and straw of peanut plants as affected by method and rate of cobalt application.

Method of cobalt addition	Seeds (Kg/fed)								
	N-uptake			P-uptake			K-uptake		
Control	19.02			1.47			13.67		
	Co I	Co II	Mean (A)	Co I	Co II	Mean (A)	Co I	Co II	Mean (A)
(I) Soil application	25.81	31.20	28.51	2.42	2.36	2.39	19.12	22.70	20.91
(II) Foliar	24.21	29.67	26.94	2.56	2.27	2.42	16.50	21.33	18.92
(III) Coating	22.02	27.38	24.70	2.62	2.19	2.41	16.96	18.25	17.61
Mean(B)	24.01	29.42	-	2.53	2.27	-	17.52	20.76	-
L.S.D 0.05	A= 0.94 B= 0.78 AXB= NS			A= NS B= 0.10 AXB= 0.19			A= 0.23 B= 0.17 AXB= 0.52		
	Straw (Kg/fed)								
	N-uptake			P-uptake			K-uptake		
	29.24			2.93			24.90		
(I) Soil application	35.87	44.94	40.40	3.75	3.39	3.57	32.66	36.46	34.56
(II) Foliar	40.15	45.79	42.97	3.88	3.51	3.69	42.74	49.99	46.36
(III) Coating	44.26	49.86	47.06	4.31	3.69	4.00	44.64	58.39	51.52
Mean(B)	40.10	46.86	-	3.98	3.53	-	40.01	48.28	-
L.S.D 0.05	A= 2.42 B= 1.86 AXB= NS			A= 0.22 B= 0.15 AXB= NS			A= 1.77 B= 1.41 AXB= 2.43		

(I): Co I = 2Kg Co fed^{-1} (II): Co I = 0.5g Co / liter. (III): Co I = 0.01 g / Kg seeds.
Co II = 4Kg Co fed^{-1} Co II = 1.0g Co / liter. Co II = 0.02 g / Kg seeds.

The interaction effect between the applied methods and rates of Co seemed to be insignificant for Fe, Mn, Zn, Cu and Co uptake by peanut seeds. The situation seemed somewhat different upon taking into consideration such an interaction effect on Fe, Zn, Cu and Co uptake by peanut forage, where significant relationship could be realized. However, the interaction effect on values of Mn uptake by peanut forage was insignificant.

Table (4A): Fe, Mn, Zn, Cu, and Co uptake values (g fed^{-1}) by peanut seeds as affected by methods and rates of cobalt application.

Method of cobalt addition	Seeds (g / fed)		
	Fe		
Control	71.32		
	Co I	Co II	Mean (A)
(I) Soil application	94.33	113.95	104.14
(II) Foliar	88.45	108.36	98.41
(III) Coating	80.41	100.05	90.23
Mean(B)	87.73	107.45	-
L.S.D $_{0.05}$	A= 2.17 B= 1.77 AXB=NS		
	Mn		
	26.74		
(I) Soil application	40.45	47.17	43.81
(II) Foliar	36.31	44.81	40.56
(III) Coating	32.96	41.25	37.11
Mean(B)	36.57	44.41	-
L.S.D $_{0.05}$	A= 1.45 B= 1.18 AXB=NS		
	Zn		
	17.83		
(I) Soil application	28.37	34.27	31.32
(II) Foliar	26.59	32.59	29.59
(III) Coating	24.19	30.07	27.13
Mean(B)	26.38	32.31	-
L.S.D $_{0.05}$	A= 1.39 B= 1.14 AXB=NS		
	Cu		
	9.11		
(I) Soil application	16.03	19.36	17.69
(II) Foliar	15.03	18.43	16.73
(III) Coating	13.67	16.98	15.33
Mean(B)	14.91	18.26	-
L.S.D $_{0.05}$	A= 0.19 B= 0.15 AXB=NS		
	Co		
	2.45		
(I) Soil application	3..90	4.70	4.30
(II) Foliar	3.67	4.50	4.08
(III) Coating	3.33	4.15	3.74
Mean(B)	3.63	4.45	-
L.S.D $_{0.05}$	A= 0.07 B= 0.001 AXB = NS		

(I): Co I = 2Kg Co fed^{-1} (II): Co I = 0.5g Co / liter. (III): Co I = 0.01 g / Kg seeds.
Co II = 4Kg Co fed^{-1} Co II = 1.0g Co / liter. Co II = 0.02 g / Kg seeds.

Table (4 B): Fe, Mn, Zn, Cu, and Co uptake values (g fed^{-1}) by peanut straw as affected by methods and rates of cobalt application.

Method of cobalt addition	Seeds (g / fed)		
	Fe		
Control	117.19		
	Co I	Co II	Mean (A)
(I) Soil application	122.55	154.13	138.34
(II) Foliar	136.73	157.06	146.89
(III) Coating	148.31	167.96	158.14
Mean(B)	135.86	159.72	-
L.S.D $_{0.05}$	A= 4.59 B= 3.75 AXB= 6.50		
	Mn		
	42.92		
(I) Soil application	47.99	60.78	54.39
(II) Foliar	54.01	61.90	57.96
(III) Coating	59.82	67.71	63.77
Mean(B)	53.94	63.46	-
L.S.D $_{0.05}$	A= 2.60 B= 2.13 AXB= NS		
	Zn		
	34.60		
(I) Soil application	39.89	49.97	44.93
(II) Foliar	44.64	50.92	47.78
(III) Coating	49.24	55.43	52.34
Mean(B)	44.59	52.11	-
L.S.D $_{0.05}$	A= 0.45 B= 0.37 AXB= 0.63		
	Cu		
	14.36		
(I) Soil application	19.76	24.80	22.28
(II) Foliar	22.14	25.27	23.70
(III) Coating	24.40	27.50	25.95
Mean(B)	22.10	25.85	-
L.S.D $_{0.05}$	A= 0.15 B= 0.13 AXB= 0.23		
	Co		
	2.94		
(I) Soil application	3.65	4.61	4.13
(II) Foliar	4.11	4.69	4.40
(III) Coating	4.52	5.10	4.81
Mean(B)	4.09	4.80	-
L.S.D $_{0.05}$	A= 0.11 B= 0.10 AXB= 0.17		

(I): Co I = 2Kg Co fed^{-1} Co II = 4Kg Co fed^{-1} (II): Co I = 0.5g Co / liter. Co II = 1.0g Co / liter. (III): Co I = 0.01 g / Kg seeds. Co II = 0.02 g / Kg seeds

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كفاءة طرق ومعدلات إضافة الكوبلت علي النمووالمحصول والتركيب العنصرى لنباتات الفول السودانى النامية في أرض رملية.

مصطفى عبد العاطي ناصف*، عادل محمد عبد الحميد*، هيثم محمد شحاتة سالم**، أمل فتحى عبد الحميد*

* معهد بحوث الأراضى والمياه والبيئة- مركز البحوث الزراعية- الجيزة - مصر

** قسم الأراضى- كلية الزراعة بمشتهر- جامعة الزقازيق (فرع بنها)

أجريت تجربة حقلية بمحطة البحوث الزراعية بالإسماعلية لدراسة كفاءة طرق ومعدلات إضافة الكوبلت علي النمووالمحصول والتركيب العنصرى لنباتات الفول السوداني النامية فى أرض رملية تحت نظام الري بالرش ولقد أوضحت النتائج أن:-

مؤشرات النموومكونات المحصول للفول السوداني قد زادت بدرجة كبيرة ومعنوية بزيادة معدلات إضافة الكوبلت حتى المستوى الأعلى وهو ٤ كجم / فدان، ٢٥٠ لتر بتركيز ١ جم / لتر / فدان ، ٠,٠٢ جم /كجم بذور لكل من الإضافات السطحية والرش وتغليف البذور علي الترتيب ومع ذلك فإن رفع معدل إضافة الكوبلت قد أثر عكسيا علي مؤشرات النمووالتى ظلت قيمها بالرغم من ذلك أعلي معنويا من القيم المتحصل عليها من معاملة المقارنة.

وقد أعطت طريقة الإضافة الأرضية للكوبلت أفضلية أعلي مقارنة بطريقتي الإضافة الأخرتين (الرش الورقي & تغليف البذور) لمعظم القياسات النباتية موضع الدراسة. كما توضح النتائج أن الكوبلت عند أي معدل أوطريقة إضافة قد حقق زيادة معنوية فى الكمية الممتصة من عناصر النتروجين، الفوسفور ، البوتاسيوم، الحديد، المنجنيز، الزنك ، النحاس والكوبلت .

وبصفة عامة، فإن المعدل الأقل من الكوبلت كان أكبر تأثيرا من المستوى الأعلي بالنسبةلإمتصاص العناصر الدراسة فيما عدا عنصري النتروجين والبوتاسيوم حيث كان العكس صحيحا.