

Role and Importance of Cobalt Nutrition on Groundnut (*Arachis hypogaea*) Production

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Abstract: Two field experiments were carried out to evaluate role and importance of cobalt under different levels of nitrogen on nodules efficiency, growth, yield, minerals composition and chemical characteristics of groundnut plants. The experiments were conducted at Research and Production Station, National Research Centre, El-Nobaria Beheara Governorate, Delta- Egypt, under drip irrigation system during 2011 and 2012 seasons.

The obtained results are summarized in the following:

- Cobalt significantly increased nitrogenase activity which was parallel and related to the increased nodules numbers, weights and its efficiency especially with both 100 and 75% nitrogen fertilizer.
- Cobalt gave the highest figures of all growth and yield parameters of Groundnut with 100% N followed by 75% N compared with the untreated plants.
- Growth and yield parameters of groundnut treated with cobalt and 50% N was not significant while cobalt with 25% N gave the lowest figures.
- Cobalt increased the efficiency of nitrogen fertilization, amendment reduce the recommended dose of about by 25% and resulted in superior pods and oil yields about by 25.6% and 18.84 with 75% N Respectively, compared with 100 N without cobalt.
- Cobalt significantly increased the content of N, P, K, Mn and Zn as well as chemical contents especially with 100% and 75% nitrogen levels.
- Increasing cobalt in plant media reduced iron content, there are antagonistic relationships between two elements (Fe & Co).

Finally, the addition of Cobalt to the soil, save 25% nitrogen and could be reduced the nitrogen environmental pollution and induced the agricultural cost for more money of farmers.

Key words: Cobalt and nitrogen • Groundnut yield • Nodulation • Nitrogen fixation

INTRODUCTION

Cobalt is an essential element for legumes because of its use by micro organisms in fixing atmospheric nitrogen [1]. Cobalt is an important in the plant world. Bacteria on root nodules of legumes (Beans – alfalfa and clover) required cobalt to synthesize vitamin B12 and Fix nitrogen from air [2].

The results [3] showed that the importance of cobalt to the growth and development of leguminasea plants was mainly due to the effect of cobalt on the activity and population of both atmospheric nitrogen micro-organisms

of *Azotobacter* and *Nitrobacter*. Cobalt is an essential element for the synthesis of vitamin B12 which is required for animals and human nutrition [4].

Authors [5] pointed that cobalt at the rate of 2.0mg/kg soil gave the highest fresh and dry weights of *Phaselus vulgaris* compared with the control. The results [6] showed that cobalt at 1.0 ppm increased growth yield of groundnut compared with the control. Soybeans grown without cobalt are severely retarded and exhibit severe nitrogen deficiency, leading the death in about one of four plants. Adding only a few ounces of cobalt per acre resolve deficiency symptoms in 10 to 21 days [7].

Cobalt also promotes many developmental processes including stem and coleoptiles elongation, opening of hypocotyls hooks, leaf disc expansion and root development [8]. Authors [9] reported that the addition of cobalt at 1.0 mg/liter in plant media slightly increased vitamin B₁₂ production, number and weight of root nodules in (*Lupinus* spp) plants compared with control. Authors [10-11] reported that cobalt at 0.21 kg/ha increased plant height, number of branches and leaves, leaf area index, dry weight of shoots as well as pods yield of groundnut. [12-13] Found that cobalt recorded the maximum leaf area index, dry matter accumulation in aerial parts of the plants, root dry weight, plant height as well as pods yield in both cowpea and groundnuts compared with the control. The results [14] showed that cobalt at 0.21 kg/ha increased plant height, number of branches per plant, leaf area index, dry weight and leg haemoglobin content of groundnut plants compared with control. Recently, [15] pointed that the cobalt application at 8 ppm level had a greatest nodulation and effective nodules in pea plants (*Pisum sativum* L.). Cobalt also, increased both fresh and dry weights of shoots and roots, pods yield quantity and quality, chemical constituents such as total solids (TSS), protein percentage as well as macronutrients (N, P and K) and micronutrients (Mn, Zn and Cu) in seed. It was found that cobalt at 0.16 mg g⁻¹ level showed significantly higher nodule number and weight, nodule N concentration, leg haemoglobin content, total biomass production and seeds yield compared with untreated plants [16].

Recently, results [17] showed that cobalt application at 50 mg/kg soil had a beneficial effect on biochemical contents i.e. sugar, protein and amino acids of groundnut seeds compared with control plants. Authors [18]

found that cobalt at level 50 mg/kg soil increased number of nodules, growth parameters such as root and shoot length, total leaf area, shoots and roots dry weights along with photosynthetic pigments viz., chlorophyll “a”, chlorophyll “b” and total chlorophyll content of groundnut plants compared the control.

More recently, authors [19] pointed that the amendment of cobalt (12ppm) to the soil improved the growth parameters, nodules number and weight, nitrogenase activity, seeds yield as well as minerals composition and chemical contents of faba bean seeds compared with untreated plants.

The aim of the present work is to evaluate the Role and importance of cobalt nutrition on groundnut (*Arachis hypogaea*) production under nitrogen fertilizer levels.

MATERIAL AND METHODS

Soil Analysis: Physical and chemical properties of Nubaria Soil were determined and particle size distributions along with soil moisture were determined as described by [20]. Soil pH, EC, cations and anions, organic matter, CaCO₃, total nitrogen and available P, K, Fe, Mn, Zn, Cu were run according to [21]. Determination of soluble, available and total cobalt was determined according to method described by [22]. Some physical and chemical properties of Nubaria soil are shown in Table (1)

Experimental Works: A preliminary experiment was conducted to evaluate the nitrogen sources on the groundnut growth. This experiment was carried out at greenhouse of National Research Centre to define the

Table 1: Some physical and chemical properties of Nubaria soil

Physical properties											
Particle size distribution%				Soil moisture constant%							
Sand	Silt	Clay	Soil texture	Saturation	FC	WP	AW				
70.8	25.6	3.6	Sandy loam	32.0	19.2	6.1	13.1				
Chemical properties											
				Soluble cations (meq ^l L)				Soluble anions (meq ⁻¹ L)			
pH 1:2.5	EC (dS m ⁻¹)	CaCO3%	OM %	Ca ⁺⁺	Mg ⁺⁺	K ⁺	Na ⁺	HCO ₃ ⁻	CO ₃	Cl ⁻	SO ₄ ⁼
8.49	1.74	3.4	0.20	0.8	0.5	1.6	1.80	0.3	-	1.9	0.5
Cobalt			Total	Available			Available micronutrients				
ppm			mg 100 g ⁻¹ soil			Ppm					
Soluble	Available	Total	N	P	K	Fe	Mn	Zn	Cu		
0.35	4.88	9.88	15.1	13.3	4.49	4.46	2.71	4.52	5.2		

FC (Field capacity), WP (Wilting point), AW (Available water)

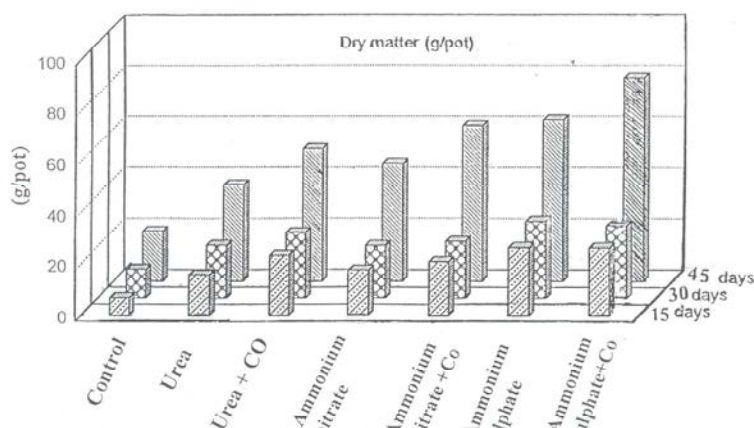


Fig. 1: Effect of nitrogen sources with cobalt on groundnut plants biomass during 45 days from planting

Table 2: Some properties of chicken manure

O.M %	Total N (%)	C/N ratio	PFI (1:25)	EC Dsmt	Available nutrients (%)		DTPA-extractable			
					P	K	Te	Mn	Zn	Cu
36.0	2.96	7.07	6.40	8.85	0.72	0.93	566	36.8	28.2	34.7

best nitrogen source on groundnut growth during 2010 season. Seedling of groundnut treated with three nitrogen sources i.e urea, ammonium nitrate and ammonium sulphate with and without cobalt.

Fig. (1) Reveal that Ammonium sulphate with cobalt had a highest dry matter yield of groundnut shoots during 15, 30 and 45 days from planting.

Two Field experiments were carried out to evaluate groundnut physiological and chemical response to cobalt nutrition with different levels of nitrogen. The sandy loam soil with plot area consists of five ridges, 3.5 meter in length and 60 cm width ($10.5\text{m}^2 = 1/400$ fed). Calcium super phosphate (15.5%) at the rate of 200 kg P_2O_5 /fed, chicken manure at the rate of 15 m^3 /fed (Table 2) and potassium sulphate (48% k_2O) at the rate of 100 kg /fed were added during soil preparation. Seeds of groundnut (*Arachis hypogaea* mill, cv. Giza- 6) was inoculated prior to sowing with a specific strain of rhizobium (*bradyrhizobium* sp.). Seeds were sown on April, 2011 and 2012 summer seasons.

Ammonium sulphate NH_4SO_4 (20.5% N) at the rate of 325 kg/fed was basic amount (100% N) as control. The levels of ammonium sulphate treatments were calculated to be corresponding to 25, 50 and 75% of the control. The seedlings (at the third true leaf) were irrigated once with 8 ppm cobalt [23].

A number of 8 treatments were concluded:

- NH_4SO_4 100% recommended dose as control
- NH_4SO_4 75%

- NH_4SO_4 50%
- NH_4SO_4 25%
- NH_4SO_4 100% + Co (8ppm)
- NH_4SO_4 75% + Co (8ppm)
- NH_4SO_4 50% + Co (8ppm)
- NH_4SO_4 25% + Co (8ppm)

All required agricultural managements for plants growth and production were carried out as recommended by Ministry of Agriculture.

Measurements of Vegetative Growth: After 80 days from sowing, all growth parameters of groundnut plants such as plant height, root length, number of branches and leaves as well shoot and root fresh and dry weights were recorded according to [24].

Nodulation and Nitrogenase Activity: Nodules number and weight were recorded after 50 days from sowing. Nitrogenase activity was determined according to [25]. Groundnut plants were gently uprooted then the root nodules were placed in 500 ml serum bottles and were sealed with suba-seal rubbers and 10% of the gas phase was replaced by C_2H_2 then bottles were incubated in dark at room temperature for 2hr. production of C_2H_4 was measured by injecting one ml gas sample into (GC). Nitrogenase activity values were recorded as $\mu\text{mol C}_2\text{H}_4/\text{g/h}$.

Measurements of Plant Yield: After 120 days from sowing groundnut yield parameters such as pods number/plant, weight of pods/plant, weight of seeds/plant, 100 seeds weight, total pods yield (kg/fed), total pods yield (Ton/fed) were recorded according to [26].

Nutritional Status: Groundnut, seeds sampled either from the intact plant for each treatment of both seasons was oven dried at 70°C for 48 hr ground and kept to chemical determinations. For extraction a weight of 0.2 g finely powdered dry sample and digested using a mixture of sulfuric acid (H_2SO_4) with hydrogen peroxide (H_2O_2). Macronutrients (N, P and K as well as micronutrients such as Fe, Mn, Cu along with cobalt were determined according to the method described by [22].

Chemical Constituents: The percent of total carbohydrates, total soluble sugars, total soluble solids, of groundnut seeds were determined according to [27]. Also total phounds Aqueous acetone (70%) was determined according to [28].

Seeds Oil Fatly Acids Content: Groundnut Seeds oil fatly acids content was determined using soxhelt apparatus and n-Hexan as solvent, according to [29].

Statistical Analysis: All data were subjected to statistical analysis according to procedure outlined by [30] computer program and means were compared by LSD method according to [31].

RESULTS AND DISCUSSION

Vegetative Growth: Data presented in Table (3) outline the response of groundnut growth parameters to cobalt

and different nitrogen levels. It is clear that cobalt promotes all growth parameters such as plant height, root length, number of branches and leaves especially with 100% and 75% nitrogen in both 2011 and 2012 seasons. Growth parameters in groundnut plants treated with cobalt and 50% nitrogen was not significant while cobalt with 25% nitrogen gave the lowest figures. Cobalt addition enhanced all growth parameters of groundnut plants grown under 100% and 75% nitrogen in two seasons. These results are in harmony with [32] who found that favorable growth responses associated with low cobalt level attributed to low catalase and peroxidase enzymes activity. These enzymes are known to induce plant respiration possibly resulting in successive consumption for products of photosynthesis and subsequently reduction plant growth. Similar results are reported by authors [33] who added that cobalt at 50 mg/kg soil increased all growth parameters, pigment contents antioxidant enzymes like catalase, peroxidase and polyphenol oxidase in greengram plants compared with the control. Data in the Tables (3) revealed that cobalt application had a promotive effect on both fresh and dry matter content of groundnut plants treated with 100% and 75% nitrogen compared with the control dose (100% N alone) at intervals of 80 days from sowing. These results are agreed with those of [34] who found the stimulation effect of cobalt on plant metabolism and endogenous plant hormones. Cobalt significantly increased endogenous auxins and gibberellins concentration compared with control.

Data in Table (3) also showed that the normal doses (100%) of mineral fertilizers gave a promotive effect on dry weights of shoots and roots. As the percent of normal doses decreased, the dry weights of groundnut shoots and roots decreased. Cobalt enhanced groundnut biomass with all nitrogen doses.

Table 3: Groundnut growth parameters as affected by cobalt under different nitrogen levels after 80 days from sowing. (means of two seasons)

Nitrogen treatments (%)	Plant high (cm)	Number/plant		Leaf area (cm ²)	Root length (cm)	Dry weight (gm)	
		Branches	Leaves			Shoot	Root
Without Cobalt							
100	26.9	7.2	69.8	2189	12.9	47.6	4.68
75	24.3	7.0	68.0	2131	12.1	45.1	3.90
50	22.0	6.2	65.9	1287	10.9	42.5	3.52
25	20.4	5.3	62.8	1132	10.2	40.0	2.19
With Cobalt (8 ppm)							
100	33.5	10.3	73.7	2378	16.7	55.5	6.55
75	32.0	10.0	72.0	2347	16.2	52.2	5.74
50	29.1	9.11	70.1	2332	15.0	48.7	4.96
25	26.7	8.05	68.5	1672	13.6	45.3	3.89
LSD 5%	0.2	0.2	0.6	30	0.5	0.2	0.06

Table 4: Groundnut nodulation parameters as affected by cobalt under different nitrogen levels after 50 days from sowing.(means of two seasons)

Nitrogen treatments (%)	Nodules Number per plant	Nodules fresh weight per plant	Nodules dry weight	Nitrogen activity $\mu\text{molC}_2\text{H}_2$
Without Cobalt				
100	128.6	11.41	3.56	17.8
75	120.0	11.15	3.33	16.5
50	113.2	10.15	3.08	15.7
25	108.6	9.76	2.96	15.1
With Cobalt (8ppm)				
100	162.3	15.78	4.90	20.9
75	149.9	15.30	4.52	19.2
50	133.5	14.87	4.45	17.9
25	124.5	14.34	3.87	17.2
LSD 5%	4.0	0.5	0.16	0.35

The obtained results clearly indicate that treatment of 25%N with cobalt increased the rate of plants growth compared with the growth of plants treated with 100%N without cobalt. These results are agree with those obtained by authors [35] who showed that cobalt at 8ppm with 25% nitrogen fertilizer increased shoots and roots biomass of cowpea plants compared the growth of plants treated with 100% N nitrogen fertilizer without cobalt.

Nodulation Parameters: Data presented in Table (4) reveal that cobalt had a significant synergistic effect on groundnut root nodules parameters such as total nodules number / plant, fresh and dry weights of nodules under all nitrogen percentages compared with the untreated plants. Cobalt gave the highest nodules parameters of groundnut with 100% nitrogen followed by 75% nitrogen compared the control (100% N alone) after 50 days from sowing for the two seasons. Cobalt with 50% nitrogen was not significant while with 25% nitrogen gave the lowest values. These results are in harmony with those obtained by authors [36]. Who stated that cobalt application improves the nodules number per plant and increased the formation of leg hemoglobin required for nitrogen fixation. Similar results are reported by [11] who found that cobalt increased number and dry weights of nodules per plant as well as leghemoglobin content in groundnut roots especially with phosphobacterium.

Data in Table (4) also showed that cobalt addition significantly increased the activity of nitrogenase of groundnut root nodules with different nitrogen percentages after 50 days from sowing for both two seasons compared with the untreated plants. Cobalt recorded the maximum nitrogenase activity with 100% nitrogen followed by 75% nitrogen while with 50% nitrogen, cobalt was not significant. Cobalt with 25% nitrogen gave the minimum activity. These results are agree with those reported by [11] those stated that cobalt improved nodules of groundnut, also they

suggested that with cobalt treatment nodules bacteroid content and leghemoglobin were linearly related to cobalamin content. According to [37], cobalt is an essential element for growth of *rhizobium*, the specific bacteria involved in legume nodulation and fixation of atmospheric nitrogen into amino acids and proteins in legumes. Finally, cobalt is an essential element for legumes due to bacteria on root nodules and to synthesize vitamin B₁₂ which required for the microorganisms fixing nitrogen in nodules and nitrogenase activity in groundnuts.

Cobalt saved about 25% of the recommended nitrogen fertilizer dose.

Pods yield Characteristics: Table (5) exhibit the effect of cobalt on groundnut yield parameters under different levels of nitrogen. Cobalt had a significant promotive effect on number and weight of pods / plant, weight of seeds / plant and total pods yield especially with 100% and 75% nitrogen compared with the control (100% nitrogen alone). Cobalt addition in plant media increased total pods yield (ardab/fed=75kg) about 25.6% and 18.8% respectively in under 100% N level, whereas under 75% nitrogen. These results agree with those obtained by authors [23]. Under 50% nitrogen, cobalt was insignificant. However, cobalt with 25% nitrogen gave the lowest yield quantity. Data in this respect reveal that, cobalt saved 25% from the recommended dose (100% nitrogen). These data are in harmony with those obtained by [38] who pointed out that cobalt is a necessary element to legumes, in particular, for nodule formation and nitrogen fixation.

Nutritional Status: Data in Table (6) showed that cobalt with the complete dose of nitrogen fertilizer (100%) had better status of N, P, K, Mn, Zn, in groundnut seeds, Under 75%N level, cobalt had a significant beneficial effect on the status of N, P, K, Mn, Zn, in groundnut seeds compared the control (100% Nitrogen without cobalt).

Table 5: Groundnut yield parameters as affected by cobalt Under different nitrogen levels after 120 Days from sowing. (means of two seasons)

Nitrogen treatments (%)	Pods number per plant	Pods weight plant (gm)	Weight 100 seeds (gm)	Seeds yield Plant (gm)	Pods yield (ardab/fed)	oil%	Oil yield (kg/fed)
Without Cobalt							
100	26.4	34.6	48.8	18.5	18.0	42.3	600.7
75	22.3	28.8	42.9	14.3	16.8	43.5	507.8
50	18.6	23.2	36.0	11.0	15.9	40.8	402.3
25	15.0	20.5	31.7	9.8	14.5	38.9	338.8
With Cobalt (8 ppm)							
100	36.6	43.3	54.9	22.5	24.0	49.8	819.8
75	33.0	40.0	54.0	20.0	22.6	47.0	713.9
50	26.4	32.5	45.1	17.3	18.2	45.5	579.2
25	21.0	26.0	39.3	11.6	16.8	42.2	442.8
LSD 5%	1.2	2.5	2.7	0.5	115	0.5	40.2

Table 6: Minerals composition in groundnut seeds as affected by cobalt under different nitrogen levels (mean of two seasons)

Nitrogen treatments (%)	Macronutrients (%)			Micronutrients (ppm)				
	N	P	K	Mn	Zn	Cu	Fe	Cobalt (ppm)
Without Cobalt								
100	1.63	0.124	1.61	21.6	14.2	17.7	45.0	0.98
75	1.59	0.119	1.52	19.0	13.0	16.2	42.6	0.85
50	1.39	0.113	1.43	17.3	11.9	14.7	40.5	0.69
25	1.24	0.107	1.19	16.1	10.4	12.3	38.3	0.63
With Cobalt (8 ppm)								
100	2.23	0.178	1.96	27.3	18.4	20.8	38.8	3.46
75	2.11	0.153	1.88	25.0	17.1	17.7	36.1	2.89
50	1.89	0.149	1.59	22.4	15.5	15.1	32.9	2.56
25	1.69	0.139	1.26	19.7	13.2	13.6	30.3	2.30
LSD 5%	0.4	0.5	0.2	0.8	1.2	1.3	0.3	0.7

Cobalt with 50% nitrogen was not significant. However, cobalt with 25% nitrogen gave the lowest mineral composition. This may go along with the finding of [39-40], they pointed that cobalt had a beneficial effect in nutritional status of *phasolous vulgaris* and faba bean plants.

Cobalt is essential for growth of the *rhizobium*, the specific bacteria involved in legume nodulation and fixation of atmospheric nitrogen into amino acids and proteins in legumes. Vitamin B12 which contains cobalt is synthesized by the *rhizobium* and circulated in hemoglobin. The hemoglobin content in nodules directly to nitrogen fixation. Thus a deficiency Vitamin B12 production and lower nitrogen fixation. Data presented in Table (6) show the positive effect of cobalt on mineral composition (N, P, K, Mn, Zn and Fe) of groundnut seeds in both two seasons. Data reflected the superiority of cobalt with 100% nitrogen and the favorable effect of cobalt with 75% nitrogen. Cobalt with 50% N was non significant and with 25% nitrogen gave the lowest nutritional status. These results are in good agreement with those found by [6] who stated that cobalt had a promotion effect for better minerals status in groundnut seeds (except Fe) compared with the control.

[11] Added that cobalt gave a higher oil content and superior nutrients uptake by groundnut seeds compared with the control. According to [41], all minerals content of blackgram were increased with cobalt at 50 mg/kg soil when compared with the control. On the other hand, these results are agree with [42-43], who stated that, cobalt addition in plant media resulted in proportion significant reduction in iron content. This indicates, again, the competition between cobalt and iron content in soybean and canola shoots and seeds.

Chemical Constituents: The amount of protein, total carbohydrate, total soluble sugars, total soluble solids and oil percentages in groundnut seeds as affected by cobalt and different nitrogen levels are given in Table (7). Results indicate that all the mentioned parameters were significantly increased by cobalt nutrition with all nitrogen Levels. Cobalt increased all chemical contents as a quality of groundnut seeds.

These results are in harmony with those obtained by [44]. Revealed that cobalt addition in plant media increased protein, starch, total soluble sugars total soluble solids as well as vitamins "A" and "C" in sweet potato.

Table 7: Chemical content of groundnut seeds as affected by cobalt under different nitrogen levels (means of two seasons)

Nitrogen Treatments (%)	Protein	Total Carbohydrates	Total soluble sugar	Total soluble solids	Oil	Total phenols
------(%)-----						
Without Cobalt						
100	10.2	27.9	8.93	35.6	45.3	1.66
75	9.93	26.3	8.36	35.2	43.0	1.62
50	8.67	25.0	8.08	34.9	40.8	0.96
25	7.74	23.9	7.95	34.5	38.9	0.93
With Cobalt (8 ppm)						
100	13.9	32.6	10.19	38.8	49.8	1.56
75	13.2	30.0	9.82	38.5	47.0	1.72
50	11.8	28.4	9.64	38.1	45.5	1.59
25	10.5	25.5	9.42	37.9	42.2	1.35
LSD 5%	0.7	0.5	0.15	0.2	2.2	0.03

Table 8: Oil fatty acids in groundnut seeds as affected by cobalt under different nitrogen levels (means of two seasons)

Cobalt treatment	Without cobalt				With cobalt (8 ppm)			
	Nitrogen treatments (%)				Nitrogen treatments (%)			
	100	75	50	25	100	75	50	25
Fatty acids (%)	100	75	50	25	100	75	50	25
Palmitic (C16:0)	8.92	8.57	8.33	7.83	7.76	7.42	7.19	6.88
Stearic (C18:0)	2.38	2.29	2.11	1.90	2.15	2.05	1.94	1.86
Arachidic (C20:0)	0.85	0.81	0.76	0.63	0.79	0.75	0.69	0.66
Behenic (C22:0)	6.56	6.50	6.21	5.67	5.76	5.43	5.21	5.06
Lignoceric (C24:0)	1.23	1.19	1.16	1.11	1.13	1.05	1.02	0.97
Total sat. fatty acids (TS)	19.94	19.36	18.57	17.19	16.74	16.70	16.05	15.43
Palmitoleic (C16:1)	-	-	-	-	-	-	-	-
Oleic (C18:1)	30.22	29.83	28.89	28.73	32.67	30.77	28.96	26.59
Linoleic (C18:2)	12.21	12.06	11.72	11.48	13.88	13.56	13.25	13.08
Linolenic (C18:3)	4.35	4.18	4.09	3.87	5.38	5.33	5.22	5.13
Eicosenole (C20:1)	0.50	0.46	0.39	0.35	0.64	0.55	0.49	0.46
Erucic (C22:1)	-	-	-	-	-	-	-	-
Total unsat. fatty acids	47.48	46.63	45.09	44.43	52.57	50.27	47.92	45.26
Tu/Ts	2.38	2.41	2.43	2.58	3.14	3.01	2.99	2.93

Data in Table (7) also indicate that cobalt significantly increased the percentage of total phenols content (1.96% with 100% N) less 2.0% safety human health. This results is good agreement with those obtained by [28, 45].

Fatty Acids Content in Groundnut Oil Seed: The present data in Table (8) show that, oleic acid was the major fatty acid in groundnut oil seeds. Data indicate that cobalt decreased in the principal saturated fatty acids is palmitic. Under all nitrogen levels cobalt reduced in the saturated fatty acids such as Palmitic (C16:0), Stearic (C18:0), Archidic (C20:0), Behenic (C22:0) and Lignoceric (C24:0). Cobalt induced a reduction in the percentage of total saturated acids. It is worthy to mention that the decrease in the percentage of saturated fatty acids is profitable in human nutrition. Data also reveal that cobalt gave the major constituent of unsaturated

fatty acids is oleic acid (C18:1). Under all nitrogen levels, cobalt caused an increase in the percentage in the unsaturated acid such as oleic acid (C18:1), Linoleic (C18:2), Linolenic (C18:3), Eicosenole (C20:1) and Erucic (C22:1). This fatty acid Linolenic fatty acid consists of the tow components Omega3 and Omega 6, which processes an antioxidant properties. It is actually super food and is necessary to several metabolic processes [46]. Results in Table (8) indicate that cobalt with all nitrogen percentages caused an increase in the ratio of total unsaturated fatty acids to the saturated fatty acids. These results are in harmony with those obtained by authors [43] who showed that cobalt decreased saturated fatty acids while increased unsaturated fatty acids and the ratio of total unsaturated fatty acids to the saturated fatty acids compared with untreated plants. These results are profitable in human nutrition.

CONCLUSION

Our results showed that the addition of cobalt led to increase in groundnut growth as well as the quantity and quality of their yield at the usual amount of fertilizer. The result showed also that the addition of cobalt with 75% of the recommended amount of nitrogen fertilizer led to good results and often convergent with the results of full fertilization. These results lead to the conclusion that the addition of cobalt saved about 25% of recommended nitrogen fertilizer dose and enhanced groundnut yield quantity and quality. Therefore, it could be reduced the agricultural cost for more money to farmers.

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