*J.Soil Sci. and Agric. Eng., Mansoura Univ., Vol. 8 (9): 459 - 465, 2017*

# Impact of Nitrogen and Cobalt Rates on Faba Bean Crop Grown on Clayey Soil

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## ABSTRACT

Two field experiments were carried out in the two-successive winter seasons of 2014-2015 and 2015-2016 on faba bean (*Vicia faba* L.,) at El-Gemmaiza Agricultural Research Station, El-Gharbia Governorate, Egypt, located at (Lat. 30° 48′ 752" and Long. 31° 81 025"). as sake of studying study the influence of nitrogen as ammonium sulphate (20.5% N) at rates of (0.0, 7.5, 10.0 and 15.0 kg N $fed^{-1}$) and foliar spray of cobalt at rates of (0.0, 0.5 and 1.0 mg $L^{-1}$) as cobalt sulphate on yield, yield components, nutrients status. The statistical analysis of this experiment was randomized complete block design for combined two seasons.The results indicated that, faba bean yield (grains, straw and 100 grains weight) were significantly increased with the application of N compared to control. The highest significantly increases in grain, straw and roots yields of faba bean were obtained at accompanied treatments of 15.0 kg N $fed^{-1}$ with two rates of cobalt (0.5 and 1.0 mg $L^{-1}$). Foliar spray with cobalt at a rate of 1 mg $L^{-1}$ gave the highest yield and yield components. Data also show that, combined treatments of N and cobalt at all rates under study were significantly increased grain, straw and roots yields. The highest increases were obtained with applied rate of 15.0 kg N $fed^{-1}$ combined with 1.0 mg $L^{-1}$ cobalt as foliar spray. Additions of three rates of N were significantly increased N, P, K, Fe, Mn, Zn, Cu and Co contents of grains, straw, and roots. Also, two rates of cobalt–were significantly increased all nutrients in grain, straw, and roots. The highest increases also, were obtained at a rate of 15.0 Kg N $fed^{-1}$ accompanied with 1.0 mg $L^{-1}$ cobalt. Data, obtained also showed that the interaction between N and Co were increased N, P, K, Fe, Mn, Zn, Cu and Co, in grains, straw and roots especially at rate of 15.0 Kg N $fed^{-1}$ combined with 1.0 mg $L^{-1}$ cobalt. The addition of different levels of nitrogen and cobalt led to a significant increase in the availability of (N, P, K and Co) in the soil. The highest increase was may be due to the addition of 15.0 kg N $fed^{-1}$ with cobalt at a concentration of 1.0 mg $L^{-1}$.


**Keywords:** *faba bean, cobalt, Nitrogen rates, nutrients status, productivity and clayey soil.*

## INTRODUCTION

Faba bean (*Vicia faba*, L.) is one of the best important leguminous crops used for human nutrition in Egypt. All parts of the faba plant are edible. Cultivated faba bean is used as human food in developing countries and as animal feed, mainly for pigs, horses, poultry and pigeons in industrialized countries. It can be used as a vegetable, either green or dried, fresh or canned. In Egypt, mineral fertilizers, especially nitrogen, phosphate, potash and other micronutrients are being applied to increase faba bean growth and yield. Consumption of nitrogen and phosphate fertilizers has tripled during the last 30 years. This increase in consumption is due to various factors including the construction of the Aswan High Dam which reduced the quantity of suspended materials deposited on the soil during floods, which permitted for thousands of years the restoration of the fertility of Egyptian soils (Kasem Fatma, 2012).

The grain legume (pulse) faba bean (*Vicia faba* L.,) is grown world-wide as a protein source for food and feed. At the same time faba bean offers ecosystem services such as renewable inputs of nitrogen (N) into crops and soil via biological $N_2$ fixation, and a diversification of cropping systems. Even though the global average grain yield has almost doubled during the past 50 years the total area sown to faba beans has declined by 56% over the same period. Faba bean has the highest average reliance on $N_2$ fixation for growth of the major cool season grain legumes. As a consequence the N benefit for following crops is often high, and several studies have demonstrated substantial savings (up to 100-200 kg N $ha^{-1}$) in the amount of N fertilizer required to maximize the yield of crops grown after faba bean (Erik *et al.,* 2010).

Nitrogen is the most limiting nutrient for crop production in many of the world agricultural areas and its efficient use is important for the economic sustainability of cropping systems. Furthermore, the dynamic nature of N and its propensity for loss from soil-plant systems creates a unique and challenging environment for its efficient management. Crop response to applied N and use efficiency are important criteria for evaluating crop N requirements for maximum economic yield. Recovery of N in crop plants is usually less than 50% worldwide (Fageria and Baligar, 2005).

Cobalt is considered an important element in the plant bacteria root nodulation of legume required in low level particularly for fixing atmospheric nitrogen. The co-enzym cobalamine has Cobalt (III) as a met component, cheated to far nitrogen atoms at the center of pyrophyin straelure similar to that of iron in human. In rizobium species, three enzyemes are known to be cobalamin dependent with cobalt induce charge in their activities are primarily responsible for the relationship to nodulation and nitrogen fixation in legumes. Gad Nadia (2006) pointed out that cobalt at 8 mg $L^{-1}$ increased total nodules and dry weight of plant. Another studies were conducted by Gad Nadia *et al.* (2013) and (2014) also observed that significant increases fresh and dry weight of nodules in soybean and weights of pods $plant^{-1}$, seeds $plant^{-1}$ and 100 seeds of cowpea with cobalt addition 100 or 75% of nitrogen fertilizer recommended. Cobalt gave the highest values of all growth and yield parameters of cowpea with 100% N followed by 75% N compared to untreated plants. Increases in growth and yield parameters of cowpea and soybean treated with cobalt and 50% N were not significant while the addition of cobalt with 25% N gave the lowest values. Cobalt increased the efficiency of nitrogen fertilization, and reduced the recommended dose by 25% and resulted in superior cowpea pods and seeds yields about by 25.6 % and 18.84 with75% 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 rates. Weria *et al.* (2013) found that cobalt is essential for nitrogen-fixing micro-organisms, including the cyanobacteria. Jordan and Reichard (1998) and Licht *et al.* (1996) reported that role of cobalt in $N_2$ fixation is essentially attributed to its role as a cofactor of cobaltamine (Vitamin B6) which functions as a coenzyme involved in $N_2$ fixation and nodule growth. Gad Nadia (2006), reported that addition of cobalt in the plant media could be magnified the benefit of nutrients uptake by plants even at the low concentrations. Cobalt applications can levels of mineral and organic fertilizers to about 25 and 67 % of the recommended doses. Cobalt also increased fresh and dry weights of shoots and roots, nodules number and weight, contents of macro and micronutrients as well as yield pods and seeds quality. Also, cobalt is an essential element for certain microorganisms particularly and decrease nitrate accumulation and gave safety health to human. Kandil Hala (2007) reported that increasing of cobalt rates significantly increases in dry weights of roots, shoots and grain compared to control treatment. Grain yield were increased by 73.68, 130.68, 204.66 and 217.74 % due to the application of 5, 10, 15 and 20 mg $L^{-1}$, of cobalt respectively. The macro and micro-nutrients contents in faba bean plants were increased by the application of cobalt, except iron which was decreased. Gad Nadia (2010) observed that a significant increase in the canola yield was observed by applying cobalt in suitable concentration. Addition of 12.5 mg $L^{-1}$ cobalt gave a synergistic effect on canola growth, seed yield, oil yield and its quality compared to untreated plants. Also, cobalt application increased growth parameters, contents of macro and micro-nutrients and chemical contents in canola seeds as compared to control plants. Cobalt content in the canola seeds was in a sub range for human safety health. Gad Nadia *et al.* (2011).

Maher and Youssef (2008) noticed that residual soil fertility in terms of available N, P, K and Co was improved under the combined application of microbial inoculants and cobalt as compared to sole application of only an inoculant or cobalt and improved the cobalt accumulation in soil. Increasing the dose of cobalt subsequently increased the available cobalt content of the soil with a maximum value of 0.31 mg $kg^{-1}$ (Basu and Bhadoria, 2008)

The study aimed at decreasing nitrogen mineral fertilizers rates applied through foliar spray of cobalt to reduce the environmental impact of excess use of mineral fertilizers applied on a clay soil cultivated with faba bean.

## MATERIALS AND METHODS

The present study was carried out at El-Gemmaiza Agricultural Research Station, El-Gharbia Governorate, Egypt, located at (Lat. 30° 48′ 752" and Long. 31° 81 025"). The experiment had been extended for two winter seasons 2014/15 and 2015/16 on faba bean (*Vicia faba* L). Combined analysis of both seasons was discussed; the experiments were arranged in a complete randomized block design with three replicates under furrow irrigation system. The aims of this work are to study the impact of mineral nitrogen applied at four rates (0.0, 7.5, 10.0 and 15.0 kg N $fed^{-1}$) and foliar spray of cobalt at three rates (0.0, 0.5, and 1.0 mg $L^{-1}$) on yield, yield components and chemical composition of both faba bean grains, straw and available content (N, P, K and Co) in the soil. Some physical and chemical properties of soil were Tabulated 1. The soil was classified as (*Vertisols, Torrerts, Haplotorrerts, Typichaplotorrert, Clayey Hyperthermic, Sniectic*).*)*, soil taxonomy was performed according to Soil Survey Staff (2010).

**Table 1. Some physical and chemical properties of the experimental soil.**

| Seasons | Particle size distribution % | | | | Texture class | OM % | $CaCO_3$% |
|---|---|---|---|---|---|---|---|
| | Coarse sand | Fine sand | Silt | Clay | | | |
| Season$^{St.}$ 2014/2015 | 5.98 | 8.84 | 39.05 | 46.13 | Clayey | 2.30 | 2.45 |
| Season$^{nd.}$ 2015/2016 | 4.07 | 13.45 | 36.83 | 45.65 | Clayey | 2.40 | 2.86 |

| Seasons | pH (1:2.5) | EC (dS $m^{-1}$) | Soluble Anions (m molc $L^{-1}$) | | | | Soluble cations (m molc $L^{-1}$) | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | $CO_3^{--}$ | $HCO_3^-$ | $Cl^-$ | $SO_4^{--}$ | $Ca^{++}$ | $Mg^{++}$ | $Na^+$ | $K^+$ |
| Season$^{St.}$ 2014/2015 | 7.91 | 1.99 | 0.00 | 0.72 | 16.34 | 0.94 | 4.90 | 2.60 | 10.20 | 0.30 |
| Season$^{nd.}$ 2015/2016 | 7.96 | 1.79 | 0.00 | 0.67 | 14.45 | 0.88 | 5.00 | 2.10 | 8.60 | 0.30 |

| Seasons | Available macro and micro elements (mg $kg^{-1}$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | N | P | K | Fe | Mn | Zn | Cu | Co |
| Season$^{St.}$ 2014/2015 | 90.71 | 8.13 | 198.00 | 10.958 | 2.104 | 0.334 | 0.552 | 0.002 |
| Season$^{nd.}$ 2015/2016 | 109.67 | 9.16 | 226.00 | 11.682 | 2.330 | 0.394 | 0.865 | 0.003 |

Plot area was (3.0 m × 3.5 m 1/400 *i.e* $fed^{-1}$). Nitrogen was applied at rates of (0.0,22.5, 30.0 and 45.0 kg N $fed^{-1}$ as ammonium sulphate $(NH_4)_2SO_4$ (20.5% N), at four split doses, calcium super phosphate (15% $P_2O_5$) was added at a rate of 100 kg $fed^{-1}$ during soil preparation before sowing by mixing with the surface soil layer and potassium sulfate (48 % $K_2O$) was applied at the rate of 50 kg $K_2O$ $fed^{-1}$ at flowering stage of faba bean plants and cobalt sulfate (20 % Co) was used as a source of cobalt and it was added as foliar spray at rates of 0.0, 0.5 and 1.0 mg $L^{-1}$. It was sprayed twice at 45 and 60 times respectively.

The rhizobium was obtained from the bio-fertilizer production unit at the Soil, Water and Environment Research Institute Agriculture Research Center; Grains of faba bean (*Vicia faba* L), (Giza-716) were inoculated with rhizobium just before sowing at a rate of 75 kg grains $fed^{-1}$ on 15 November 2014 and 10 October 2015 under furrow irrigation system. All practices were used and plants thinned on two plants for each hill after three weeks from sowing.

At harvest, faba bean plants were collected from each plot to determine yield and yield components, i.e., grain and straw yields, 100-grains weight. Plant samples were oven dried at 70 °C, ground and prepared for digestion and analysis.

Surface soil samples were taken after harvest to determine the available N in soil which was extracted by using KCl (2N) and available (P, K and Co) which were extracted by using (AB-DTPA) at pH 7.6 according to the method of Soltanpour and Schwab (1991). N, P, K, Fe, Mn, Zn, Cu, and Co contents in plant material were determined using the procedures described by A.O.A.C. (1995).

Available N in soil and N content in plant material were determined using micro-Kjeldahl method according to Page *et al*. (1982) and A.O.A.C. (1995) and K using flame photometer.

Available P, Fe, Mn, Zn, Cu, and Co in the soil and content in plant digestion were determination by using Inductively Coupled Plasma (ICP) Spectrometry (Ultima 2 JY Plasma) according to the procedure described by "Environmental Protection Agency" EPA. (1991).

Soil samples were collected before cultivation to determine particle size distribution, according to Piper (1950). Calcium carbonate $CaCO_3$ was measured by the calcimeter method, according to Nelson (1982). Soil organic matter content was determined according to Walkley and Black method, Black (1982). pH values were determined by pH meter in 1:2.5 soil water suspension, according to Mclean (1982) Electrical conductivity (EC) was determined in the saturated soil paste extract using electrical conductivity meter. Soluble ions were also determined in saturated soil paste extract according to Page *et al.* (1982).

**Statistical analysis:**

Combined analysis for all the obtained data were statistically analyzed using MSTAT-C package program (Version 3.00) using least significant differences (LSD at 0.05 level) to compare between means according to Snedecor and Cochran (1990).

## RESULTS AND DISCUSSION

### I. Effect of nitrogen and cobalt rates applied on available N, P, K and Co in soil, mg kg$^{-1}$

The effect of applied nitrogen and cobalt rates on the values of available N, P, K and Co in soil are shown in Table 2. The data clearly showed that the addition of three rates of N fertilizer were significantly increased soil available N, P, K and Co. The highest increase was obtained due to addition of 15 kg N fed$^{-1}$. There was a significant difference increase among N rates addition.

**Table 2. Effect of nitrogen and cobalt rates applied on available N, P, K and Co content, mg kg$^{-1}$ in, soil under study (average of two seasons).**

| Treatments. | | mg kg$^{-1}$ soil | | | |
|---|---|---|---|---|---|
| N rates | Co rates | N | P | K | Co |
| 0.0 | -- | 148.4$^{d}$ | 1.498$^{d}$ | 251.1$^{d}$ | 0.006$^{d}$ |
| 7.50 | -- | 188.4$^{c}$ | 1.889$^{c}$ | 283.7$^{c}$ | 0.017$^{c}$ |
| 10.00 | -- | 235.4$^{b}$ | 2.303$^{b}$ | 332.6$^{b}$ | 0.030$^{b}$ |
| 15.00 | -- | 284.1$^{a}$ | 3.401$^{a}$ | 403.2$^{a}$ | 0.043$^{a}$ |
| LSD at 0.5 for A | | 6.14 | 0.05159 | 12.06 | 0.001153 |
| -- | 0.00 | 201.3$^{c}$ | 2.290$^{c}$ | 302.1$^{c}$ | 0.020$^{c}$ |
| -- | 0.50 | 215.3$^{b}$ | 2.253$^{b}$ | 313.5$^{b}$ | 0.023$^{b}$ |
| -- | 1.00 | 225.6$^{a}$ | 2.537$^{a}$ | 337.3$^{a}$ | 0.028$^{a}$ |
| LSD at 0.5 for B | | 2.478 | 0.09077 | 9.058 | 0.0008654 |
| | 0.00 | 138.2$^{i}$ | 1357$^{k}$ | 240.3$^{h}$ | 0.002$^{k}$ |
| control | 0.50 | 190.8$^{h}$ | 1860.$^{gk}$ | 285.0$^{e}$ | 0.017$^{h}$ |
| | 1.00 | 250.3$^{d}$ | 2.560$^{d}$ | 354.0$^{c}$ | 0.035$^{d}$ |
| | 0.00 | 148.4$^{k}$ | 1530$^{jk}$ | 252.0$^{gh}$ | 0.004$^{k}$ |
| 7.50 | 0.50 | 199.8$^{g}$ | 2.020$^{fg}$ | 291.0$^{e}$ | 0.019$^{g}$ |
| | 1.00 | 274.4$^{c}$ | 2.837$^{c}$ | 376.7$^{b}$ | 0.039$^{c}$ |
| | 0.00 | 158.7$^{j}$ | 1.607$^{ij}$ | 261.0$^{f}$ | 0.011$^{j}$ |
| 10.00 | 0.50 | 218.2$^{f}$ | 2.137$^{ef}$ | 316.3$^{d}$ | 0.024$^{f}$ |
| | 1.00 | 284.3$^{b}$ | 3.407$^{b}$ | 389.5$^{b}$ | 0.042$^{b}$ |
| | 0.00 | 174.6$^{i}$ | 1.687$^{hi}$ | 275.0$^{ef}$ | 0.014$^{i}$ |
| 15.00 | 0.50 | 237.6$^{e}$ | 2.213$^{e}$ | 327.3$^{d}$ | 0.030$^{e}$ |
| | 1.00 | 293.6$^{a}$ | 3.960$^{a}$ | 443.3$^{a}$ | 0.048$^{a}$ |
| LSD at 0.5 for A X B | | 4.957 | 0.1815 | 18.12 | 0.001731 |

**Means with the same letter are not significantly different.**

Addition rates of cobalt were significantly affected to soil availability of N, P, K and Co contents. The highest increase was obtained by the addition of 1.0 mg L$^{-1}$ cobalt as compared to 0.5 mg L$^{-1}$ cobalt and control treatment.

The effect of the interaction between combination of nitrogen and cobalt treatments on soil availability of N, P, K and Co contents under study shown in Table 2. The obtained results indicated that, there was a significant difference for soil availability content of nutrients. The highest increase was obtained when the addition of 15.0 kg N fed$^{-1}$ combined with1.0 mg L$^{-1}$ cobalt may be due to the root secretion, soil pH and released soil macro nutrients with availability to plants. This result was agreed with data obtained by Maher and Youssef (2008), whose tested five levels of cobalt (0, 5, 10, 20, 40, 80, and 100 mg kg$^{-1}$ soil) and observed that the soil available cobalt concentration increased with increasing cobalt application rate. Also, Gad Nadia (2006) reported that, addition of cobalt in the plant media could be magnified the benefit of nutrients uptake by plants even at the low concentrations.

### II. Effect of nitrogen and cobalt rates on faba bean productivity and its components.

Data in Table 3 show that the addition of 10.0 and 15.0 kg N fed$^{-1}$ significantly enhanced both grain yield of faba bean, while the application of 7.5 kg N fed$^{-1}$ had no significant effect. The highest increase was obtained at a rate of 15.0 Kg N fed$^{-1}$ and the corresponding increase were 13.16% and 13.18% for grain and straw yields, respectively as compared to control treatment.

With regard to N rates applied to the soil the same trend was obtained for faba bean yield of grain and straw yield, where the addition of 10.0 and 15.0 kg N fed$^{-1}$ were significantly affected straw yield. The highest straw yield was obtained at rate of 15.0 kg N fed$^{-1}$ with corresponding increase was 13.18 % compared to control treatment.

Roots weights were also significantly affected by different rates of N fertilizer. The plants received 15.0 kg N fed$^{-1}$ gave the highest values compared to control, and there were no significant differences were obtained between the rates of 7.5 and 10.0 kg N fed$^{-1}$ applied.

The obtained result, data attained in Table 2 indicate that the addition of cobalt at two rates significantly affected faba bean productivity and its components. The highest increases were obtained by foliar spray of 1.0 mg L$^{-1}$ cobalt and the corresponding increases were 10.19, 10.75, 53.16 and 12.37 % for grain, straw, roots and biological yields, respectively.

Data in Table 3 show that the interaction effect between nitrogen soil application and foliar spray of cobalt rates on grain, straw, roots and biological yields were significant. The combined treatment of 15.0 kg N fed$^{-1}$ and 1.0 mg L$^{-1}$ foliar spray cobalt gave the highest values for grain, straw, pods and biological yield without no significant difference between this treatment and applied 15.0 kg N combined with 0.5 mg L$^{-1}$ cobalt. The interaction effects between N and Co rates on roots yield and weight of 100 grains gave also the same previous trend.

The beneficial impact of applied cobalt as foliar spray on faba been yield may be due to that, the cobalt is an essential element for nitrogen fixing by microorganisms, including the cyanobacteria these results are in accordance with Jordan and Reichard (1998). reported that, the effect of cobalt depends on enzyme system in rizobium which may account for influence of cobalt on nodulation, ribonucleotide reductase and methylalonyl coenzyme. Kandil Hala (2007) also found that, the application of cobalt to plants may help in better nodulation and consequently a better growth and yield production. On the other hand, cobalt addition increase the nodules formation of root and atmospheric nitrogen fixation by microorganisms which increase growth and yield of faba bean plants. Kandil Hala and El-Mghraby (2016) reported that, cobalt applied significantly increased faba bean and wheat yield.

**Table 3. Effect of nitrogen and cobalt rates applied on the productivity of faba bean yield (average of two seasons).**

| Treatments. | | kg fed$^{-1}$ | | | | Pods yield kg | 100 |
|---|---|---|---|---|---|---|---|
| N rates | Co rates | Grains yield | Straw yield | Roots Yield | Biological yield | fed$^{-1}$ | grains g |
| 0.0 | -- | 1429$^{c}$ | 800.4$^{c}$ | 89.64$^{c}$ | 2534$^{c}$ | 1644$^{c}$ | 87.55$^{c}$ |
| 7.50 | -- | 1457$^{bc}$ | 816.5$^{bc}$ | 97.12$^{b}$ | 2590$^{bc}$ | 1677$^{bc}$ | 91.07$^{a}$ |
| 10.00 | -- | 1492$^{b}$ | 835.4$^{b}$ | 100.5$^{ab}$ | 2652$^{b}$ | 1738$^{b}$ | 89.92$^{b}$ |
| 15.00 | -- | 1617$^{a}$ | 905.4$^{a}$ | 104.1$^{a}$ | 2869$^{a}$ | 1859$^{a}$ | 91.78$^{a}$ |
| LSD at 0.5 for A | | 61.77 | 34.47 | 4.765 | 104.5 | 94.16 | 1.096 |
| -- | 0.00 | 1423$^{c}$ | 796.9$^{c}$ | 86.73$^{c}$ | 2520$^{c}$ | 1637$^{c}$ | 89.26$^{b}$ |
| -- | 0.50 | 1506$^{b}$ | 843.3$^{b}$ | 99.71$^{b}$ | 2675$^{b}$ | 1732$^{b}$ | 88.97$^{b}$ |
| -- | 1.00 | 1568$^{a}$ | 878.0$^{a}$ | 107.1$^{a}$ | 2788$^{a}$ | 1820$^{a}$ | 92.00$^{a}$ |
| LSD at 0.5 for B | | 51.28 | 28.71 | 3.565 | 86.20 | 54.01 | 0.9401 |
| | 0.00 | 1346$^{e}$ | 753.9$^{e}$ | 74.01$^{g}$ | 2376$^{f}$ | 1548$^{e}$ | 83.53$^{f}$ |
| control | 0.50 | 1446$^{cde}$ | 809.9$^{cde}$ | 81.50$^{f}$ | 2555$^{de}$ | 1663$^{cd}$ | 87.98$^{e}$ |
| | 1.00 | 1495$^{cd}$ | 837.3$^{cd}$ | 113.40$^{b}$ | 2670$^{cd}$ | 1719$^{bc}$ | 91.13$^{bc}$ |
| | 0.00 | 1350$^{e}$ | 755.9$^{e}$ | 88.73$^{e}$ | 2397$^{ef}$ | 1552$^{e}$ | 90.06$^{cd}$ |
| 7.50 | 0.50 | 1376$^{e}$ | 771.4$^{e}$ | 107.90$^{b}$ | 2463$^{ef}$ | 1584$^{de}$ | 92.18$^{b}$ |
| | 1.00 | 1647$^{ab}$ | 922.2$^{ab}$ | 94.75$^{cde}$ | 2911$^{ab}$ | 1894$^{a}$ | 90.96$^{bc}$ |
| | 0.00 | 1549$^{bc}$ | 867.3$^{bc}$ | 90.24$^{de}$ | 2739$^{bc}$ | 1781$^{b}$ | 91.05$^{bc}$ |
| 10.00 | 0.50 | 1501$^{cd}$ | 840.8$^{cd}$ | 113.10$^{b}$ | 2681$^{cd}$ | 1727$^{bc}$ | 87.30$^{e}$ |
| | 1.00 | 1425$^{de}$ | 798.1$^{de}$ | 98.23$^{c}$ | 2535$^{def}$ | 1706$^{bc}$ | 91.41$^{bc}$ |
| | 0.00 | 1447$^{cde}$ | 810.6$^{cde}$ | 93.95$^{cde}$ | 2569$^{cde}$ | 1665$^{cd}$ | 92.40$^{de}$ |
| 15.00 | 0.50 | 1699$^{a}$ | 951.2$^{a}$ | 96.37$^{cd}$ | 3001$^{a}$ | 1953$^{a}$ | 88.43$^{de}$ |
| | 1.00 | 1704$^{a}$ | 954.5$^{a}$ | 122.10$^{a}$ | 3037$^{a}$ | 1960$^{a}$ | 94.50$^{a}$ |
| LSD at 0.5 for A X B | | 102.6 | 57.42 | 7.130 | 172.4 | 108.0 | 1.880 |

**Means with the same letter are not significantly different.**

### III. Effect of nitrogen and cobalt rates applied on N, P and K (kg fed$^{-1}$), Fe, Mn, Zn, Cu and Co, (g kg$^{-1}$) in faba bean grains yield.

Data in Table 4 show that, the application of N at different rates enhanced significantly the N, P, K, Fe, Mn, Zn, Cu and Co contents of faba bean grains and the highest increases were recorded for at soil the application at the rate of 15.0 kg N fed$^{-1}$.

With regard the effect of cobalt applied as foliar spray on nutrients status of faba bean grains, straw contents and roots. The highest nutrients contents were obtained due to foliar spray of 1.0 mg L$^{-1}$ cobalt, except for P content of grains, where there was no significant effect between foliar spraying of 0.5 or 1.0 mg Co L$^{-1}$. This may be due to the positive role of cobalt in water movement and its tendency towards the rhizosphere area near the plant zone and consequently, the enhancement occurred on mineral uptake by the growing plants, particularly in case of water stress as mentioned by Kandil Hala (2007) she reported that, the addition of different levels of cobalt namely 5.0, 10.0,15.0 and 20.0 ppm had significant beneficial effect on the status of studied macro- elements (nitrogen, phosphorus and potassium) in both shoots and roots of faba bean plants, the highest content values of N, P and K in shoots and roots were obtained at the treatment of 20.0 ppm cobalt followed by 15.0, 10.0 and 5.0 ppm in a decreasing order.

**Table 4. Effect of nitrogen and cobalt rates applied on N, P and K (kg fed$^{-1}$ and Fe, Mn, Zn, Cu and Co, (g kg$^{1}$) in faba bean grains yield (average of two seasons).**

| Treatments. | | kg fed$^{-1}$ | | | g kg$^{-1}$ | | | | |
|---|---|---|---|---|---|---|---|---|---|
| N rates | Co rates | N | P | K | Fe | Mn | Zn | Cu | Co |
| 0.0 | -- | 24.92$^{d}$ | 4.180$^{c}$ | 24.36$^{d}$ | 187.9$^{d}$ | 32.99$^{d}$ | 15.38$^{d}$ | 13.16$^{d}$ | 0.488$^{d}$ |
| 7.50 | -- | 33.09$^{c}$ | 5.186$^{c}$ | 27.37$^{c}$ | 216.0$^{c}$ | 45.90$^{c}$ | 35.56$^{c}$ | 24.29$^{c}$ | 1.332$^{c}$ |
| 10.00 | -- | 44.52$^{b}$ | 8.355$^{b}$ | 32.52$^{b}$ | 272.5$^{b}$ | 63.23$^{b}$ | 61.84$^{b}$ | 36.30$^{b}$ | 2.142$^{b}$ |
| 15.00 | -- | 60.04$^{a}$ | 11.33$^{a}$ | 43.20$^{a}$ | 342.5$^{a}$ | 106.70$^{a}$ | 94.72$^{a}$ | 57.78$^{a}$ | 4.431$^{a}$ |
| LSD at 0.5 for A | | 4.098 | 1.721 | 1.403 | 15.93 | 4.049 | 2.354 | 3.200 | 0.1210 |
| -- | 0.00 | 35.13$^{c}$ | 6.361$^{b}$ | 28.69$^{c}$ | 229.3$^{c}$ | 49.82$^{c}$ | 40.28$^{c}$ | 26.85$^{c}$ | 1.535$^{c}$ |
| -- | 0.50 | 40.36$^{b}$ | 7.490$^{a}$ | 31.90$^{b}$ | 256.4$^{b}$ | 60.72$^{b}$ | 52.30$^{b}$ | 32.87$^{b}$ | 1929$^{b}$ |
| -- | 1.00 | 46.43$^{a}$ | 7.937$^{a}$ | 35.00$^{a}$ | 279.0$^{a}$ | 76.06$^{a}$ | 63.05$^{a}$ | 38.93$^{a}$ | 2.831$^{a}$ |
| LSD at 0.5 for B | | 2.547 | 1.062 | 1.124 | 11.02 | 3.592 | 3.023 | 2.246 | 0.1254 |
| | 0.00 | 21.85$^{g}$ | 3.367$^{c}$ | 21.85$^{g}$ | 169.4$^{f}$ | 25.26$^{g}$ | 11.03$^{i}$ | 10.42$^{i}$ | 0.229$^{j}$ |
| Control | 0.50 | 25.50$^{fg}$ | 4.238$^{c}$ | 24.82$^{f}$ | 191.e$^{f}$ | 33.59$^{f}$ | 14.73$^{hi}$ | 13.73$^{h}$ | 0.482$^{i}$ |
| | 1.00 | 27.41$^{ef}$ | 4.935$^{c}$ | 26.41$^{f}$ | 202.9$^{e}$ | 40.13$^{ef}$ | 20.38$^{gh}$ | 15.34$^{gh}$ | 0.753$^{h}$ |
| | 0.00 | 26.45$^{fg}$ | 4.949$^{c}$ | 24.79$^{f}$ | 191.3$^{ef}$ | 38.25$^{ef}$ | 22.95$^{g}$ | 18.65$^{fg}$ | 1.156$^{g}$ |
| 7.50 | 0.50 | 31.68$^{e}$ | 5.372$^{c}$ | 25.76$^{f}$ | 202.2$^{e}$ | 41.10$^{e}$ | 32.04$^{f}$ | 22.39$^{f}$ | 1.254$^{g}$ |
| | 1.00 | 41.12$^{d}$ | 5.238$^{c}$ | 31.56$^{e}$ | 256.4$^{d}$ | 58.36$^{d}$ | 51.71$^{e}$ | 31.84$^{e}$ | 1.586$^{f}$ |
| | 0.00 | 44.45$^{cd}$ | 8.057$^{b}$ | 30.45$^{e}$ | 271.3$^{cd}$ | 55.39$^{d}$ | 55.05$^{e}$ | 33.82$^{e}$ | 1.605$^{f}$ |
| 10.00 | 0.50 | 44.31$^{cd}$ | 8.458$^{b}$ | 32.34$^{e}$ | 274.7$^{cd}$ | 60.54$^{d}$ | 61.22$^{d}$ | 35.46$^{de}$ | 1.972$^{e}$ |
| | 1.00 | 44.80$^{cd}$ | 8.551$^{b}$ | 34.77$^{d}$ | 271.4$^{cd}$ | 73.76$^{c}$ | 69.27$^{c}$ | 39.63$^{d}$ | 2.851$^{d}$ |
| | 0.00 | 47.77$^{c}$ | 9.072$^{b}$ | 37.68$^{c}$ | 285.0$^{c}$ | 80.40$^{c}$ | 72.10$^{c}$ | 44.50$^{c}$ | 3.152$^{c}$ |
| 15.00 | 0.50 | 59.96$^{b}$ | 11.89$^{a}$ | 44.67$^{b}$ | 357.2$^{b}$ | 107.60$^{b}$ | 101.20$^{b}$ | 59.92$^{b}$ | 4.008$^{b}$ |
| | 1.00 | 72.40$^{a}$ | 13.03$^{a}$ | 47.25$^{a}$ | 385.4$^{a}$ | 132.00$^{a}$ | 110.80$^{a}$ | 68.93$^{a}$ | 6.134$^{a}$ |
| LSD at 0.5 for A X B | | 5.093 | 2.125 | 2.249 | 22.04 | 7.183 | 6.045 | 4.493 | 0.2508 |

**Means with the same letter are not significantly different.**

The result of the interaction between nitrogen and cobalt on nutrients contents under study in faba bean grains were also illustrated in Table 3. The obtained results showed that all nutrients contents were significantly responded to all tested treatments and the addition of 15.0 kg N $fed^{-1}$ combined with 1.0 mg $L^{-1}$ cobalt gave the highest values for studied nutrients of grains, straw and roots. These data confirm with the data obtained by Kandil Hala and El-Mghraby (2016). Who found that, cobalt addition with nitrogen significantly increased N, P, K, Co, Zn, Mn and Cu content of cowpea, saybean, faba bean and wheat plants.

Data presented in Table 4 also reveal that, all the used rates of nitrogen (0.0, 7.5, 10.5 and 15.0) kg N $fed^{-1}$ and cobalt (0.0, 0.5, and 1.0) mg Co $L^{-1}$ $fed^{-1}$ significantly increased N, P and K in grains yield as well as Co, Fe, Mn, Zn and Cu as compared with control treatment. These results showed in all treatments except P that was no significantly affected at 0.5 mg Co $L^{-1}$ accompanied with 7.5 kg N $fed^{-1}$ compared to control treatment.

The highest values of NPK, Fe, Mn, Zn, Cu and Co in faba bean grains in were obtained when accompaniment 15 kg N $fed^{-1}$ with 1.0 mg Co $L^{-1}$, followed by 10.0, 7.5 and 0.0 kg N $fed^{-1}$ with 0.5 and 0.0 mg Co $L^{-1}$. This positive effect may be due to cobalt application promoted many of developmental processes and increases the formation of loghaemoglobin required for nitrogen fixation, thereby improving the nodules activity by application of cobalt. These results agreed with those obtained with Yadav and Khanna (1988) and Kandil Hala (2007) who reported that contents of macro nutrients (N, P and K) and micro nutrients (Fe, Mn, Zn, and Cu) in faba bean plants were increased with increasing of cobalt application.

Concerning the interaction effect between nitrogen soil application combined with cobalt foliar spray on N, P, K, Fe, Mn, Zn, Cu and Co concentrations in faba beans data in Table 4 show that cobalt sprayed at a rate of 1.0 mg $L^{-1}$ with full dose of nitrogen fertilizer i.e 15.0 kg N $fed^{-1}$ had the highest impact for all nutrients status under investigation. Concerning N, P and K nutrients, the highest values were found at rate of 15.0 kg N $fed^{-1}$ a combined with 1.0 mg $L^{-1}$ cobalt, followed by 15 kg N $fed^{-1}$ and 0.5 mg $L^{-1}$ cobalt, followed by 15 kg N $fed^{-1}$ without cobalt sprayed, for N and K. There were no significant differences between the dual treatments of 10.0 kg N $fed^{-1}$ with or without cobalt for N. Also, the highest values of P were found at 15.0 kg N $fed^{-1}$ with 0.5 or 1.0 mg $L^{-1}$ cobalt, followed by 15.0 kg N $fed^{-1}$ without sparing of cobalt and the last one was observed when the application of 10 kg N $fed^{-1}$ with or without cobalt. While, no significant deferens between 7.5 or zero kg N $fed^{-1}$ with or without cobalt applied. Also, data recorded that no significant differences for K at 10.0 kg N $fed^{-1}$ with zero and 0.5 mg $L^{-1}$ cobalt and 7.5 kg N $fed^{-1}$ with 1.0 mg $L^{-1}$ cobalt. Moreover, the same later with 7.5 kg N $fed^{-1}$ with zero and 0.5 mg $L^{-1}$ cobalt spray and without N $fed^{-1}$ and 0.5 or 1.0 mg $L^{-1}$ cobalt foliar spray.

Concerning the interaction effect between soil application nitrogen rates and cobalt foliar spray rates on the concentrations of micronutrients and cobalt in faba bean grains, data in Table 3 reveal that, the highest values were obtained when the addition of 15.0 kg N $fed^{-1}$ and 1.0 mg Co $L^{-1}$ followed by 10.0 kg N $fed^{-1}$ and 0.5 mg Co $L^{-1}$, respectively. Data also, show that, no significantly differences observed between the dual treatment of 7.5 kg N $fed^{-1}$ and 0.5 mg $L^{-1}$ or without cobalt for content of cobalt in faba bean grains yield. Also, at 7.5 kg N $fed^{-1}$ and 1.0 mg $L^{-1}$ cobalt foliar spray and 10.0 kg N $fed^{-1}$ without foliar spray cobalt for Co and Cu contents, respectively of faba bean grains yield. As well as the Fe content in faba bean grains was no significantly affected at 10.0 kg N $fed^{-1}$ with or without foliar spray applied of cobalt, while Mn and Zn at rate of 10.0 kg N $fed^{-1}$ with 1.0 mg $L^{-1}$ foliar spray applied of cobalt or 15.0 kg N $fed^{-1}$ without cobalt were no much difference as Fe content. These results were more or less agreed with those obtained by Gad Nadia *et al.* (2016) who observed that contents–of N, P, K, Fe, Mn, Zn, Cu and Co were significantly increased in faba bean at all nitrogen rates with cobalt applied, the highest values were obtained with 100% N followed by 75 % N. Also, cobalt content in faba bean was increased with cobalt application.

**IV. Effect of nitrogen and cobalt rates applied on macro, micro-nutrients and Co contents in faba bean straw and roots.**

Data obtained in Tables 5 and 6 shows that as generally the effect of N application rates on N, P, K, Fe, Mn, Zn, Cu and Co contents in straw yield and roots, gave significantly differences values a generally. The application of nitrogen at different rates progressively increased the faba bean straw and roots contents of nutrients under study compared to the control treatment (without N addition) and the highest values were attained by the application of 15 kg N $fed^{-1}$.

Concerning the effect of cobalt foliar spray application rates gave the same trend as nitrogen applied, where elements contents in both straw and roots increased with increasing cobalt rates. It could be concluded that, cobalt applied it was benefit on increasing elements content in faba bean straw yields or roots. These results are agree with those obtained by Nadia Gad (2006) reported that, addition of cobalt in the plant media could be magnified the benefit of nutrients uptake by plants even at the low concentrations.

Regarding the interaction effect between N and Co rates on N, P, K, Fe, Mn, Zn, Cu and Co contents of faba bean straw yield and roots, data presented in Tables 5 and 6. show significantly responses in elements content in both faba bean straw and roots when N fertilizers a combined with cobalt in straw and roots of faba bean plants. These results were in harmony with Kandil Hala (2007) who reported that, addition of different levels of cobalt namely 5.0, 10.0, 15.0 and 20.0 mg $L^{-1}$ had significant beneficial effect on the status of macro- and micronutrients in both shoots and roots of faba bean plants, the highest content vales of N, P, K, Fe, Mn, Zn, Cu and Co, in shoots and roots were obtained at the treatment of 20.0 mg Co $L^{-1}$ followed by 15.0, 10.0 and 5.0 mg $L^{-1}$ in a decreasing order.

**Table 5. Effect of nitrogen and cobalt rates applied on N, P, K, Fe, Mn, Zn, Cu and Co status in faba bean straw yield (average of two seasons).**

| Treatments. | | | kg fed$^{-1}$ | | | | g kg$^{-1}$ | | |
|---|---|---|---|---|---|---|---|---|---|
| N rates | Co rates | N | P | N | Fe | Mn | Zn | Cu | Co |
| 0.0 | -- | 12.05$^{d}$ | 1.659$^{d}$ | 7.204$^{d}$ | 85.31$^{d}$ | 88.33$^{d}$ | 29.22$^{d}$ | 8.514$^{d}$ | 0.529$^{d}$ |
| 7.50 | -- | 15.64$^{c}$ | 2.524$^{c}$ | 9.226$^{c}$ | 104.10$^{c}$ | 114.00$^{c}$ | 50.12$^{c}$ | 15.44$^{c}$ | 0.978$^{c}$ |
| 10.00 | -- | 21.46$^{b}$ | 3.637$^{b}$ | 11.50$^{b}$ | 122.90$^{b}$ | 127.70$^{b}$ | 72.11$^{b}$ | 26.87$^{b}$ | 1.760$^{b}$ |
| 15.00 | -- | 28.19$^{a}$ | 5.231$^{a}$ | 16.61$^{a}$ | 156.90$^{a}$ | 187.70$^{a}$ | 137.30$^{a}$ | 38.98$^{a}$ | 4.158$^{a}$ |
| LSD at 0.5 for A | | 1.137 | 0.2605 | 0.5568 | 6.712 | 8.098 | 5.972 | 1.566 | 0.1711 |
| -- | 0.00 | 16.84$^{c}$ | 2.639$^{c}$ | 9.815$^{c}$ | 105.10$^{c}$ | 110.40$^{c}$ | 55.13$^{c}$ | 18.56$^{c}$ | 1.454$^{c}$ |
| -- | 0.50 | 19.33$^{b}$ | 3.381$^{b}$ | 11.15$^{b}$ | 116.60$^{b}$ | 131.20$^{b}$ | 71.28$^{b}$ | 22.53$^{b}$ | 1.938$^{b}$ |
| -- | 1.00 | 21.84$^{a}$ | 3.768$^{a}$ | 12.44$^{a}$ | 130.10$^{a}$ | 146.60$^{a}$ | 90.17$^{a}$ | 26.27$^{a}$ | 2.177$^{a}$ |
| LSD at 0.5 for B | | 1.064 | 0.2155 | 0.5164 | 4.988 | 5.559 | 4.163 | 1.196 | 0.08654 |
| | 0.00 | 10.33$^{f}$ | 1.106$^{i}$ | 6.208$^{g}$ | 75.90$^{f}$ | 67.93$^{g}$ | 20.76$^{j}$ | 6.458$^{j}$ | 0.367$^{i}$ |
| Control | 0.50 | 11.58$^{f}$ | 1.807$^{h}$ | 7.422$^{f}$ | 85.47$^{ef}$ | 92.91$^{f}$ | 28.88$^{ig}$ | 8.401$^{ij}$ | 0.524$^{i}$ |
| | 1.00 | 14.23$^{e}$ | 2.065$^{gh}$ | 7.983$^{ef}$ | 94.56$^{de}$ | 104.20$^{e}$ | 38.02$^{h}$ | 10.68$^{hi}$ | 0.698$^{h}$ |
| | 0.00 | 13.86$^{e}$ | 1.940$^{h}$ | 7.660$^{ef}$ | 91.36$^{de}$ | 101.70$^{ef}$ | 36.39$^{hi}$ | 12.93$^{gh}$ | 0.811$^{gh}$ |
| 7.50 | 0.50 | 14.68$^{e}$ | 2.494$^{g}$ | 8.485$^{e}$ | 98.23$^{d}$ | 108.00$^{e}$ | 50.46$^{g}$ | 13.89$^{g}$ | 0.915$^{g}$ |
| | 1.00 | 18.38$^{d}$ | 3.137$^{f}$ | 11.53$^{d}$ | 122.60$^{c}$ | 132.20$^{d}$ | 63.50$^{ef}$ | 19.52$^{f}$ | 1.209$^{f}$ |
| | 0.00 | 19.82$^{d}$ | 3.296$^{ef}$ | 11.42$^{d}$ | 122.20$^{c}$ | 125.50$^{d}$ | 61.61$^{f}$ | 23.79$^{e}$ | 1.591$^{e}$ |
| 10.00 | 0.50 | 22.31$^{c}$ | 3.704$^{de}$ | 11.50$^{d}$ | 122.00$^{c}$ | 125.80$^{d}$ | 69.98$^{e}$ | 27.26$^{d}$ | 1.805$^{d}$ |
| | 1.00 | 22.24$^{c}$ | 3.910$^{cd}$ | 11.60$^{d}$ | 124.30$^{c}$ | 131.70$^{d}$ | 84.75$^{d}$ | 29.56$^{cd}$ | 1.884$^{d}$ |
| | 0.00 | 23.34$^{c}$ | 4.215$^{c}$ | 13.97$^{c}$ | 131.10$^{c}$ | 146.40$^{c}$ | 101.80$^{c}$ | 31.07$^{c}$ | 3.045$^{c}$ |
| 15.00 | 0.50 | 28.76$^{b}$ | 5.517$^{b}$ | 17.22$^{b}$ | 160.60$^{b}$ | 198.20$^{b}$ | 135.80$^{b}$ | 40.57$^{b}$ | 4.509$^{b}$ |
| | 1.00 | 32.49$^{a}$ | 5.960$^{a}$ | 18.65$^{a}$ | 179.00$^{a}$ | 218.40$^{a}$ | 174.40$^{a}$ | 45.31$^{a}$ | 4.919$^{a}$ |
| LSD at 0.5 for A X B | | 2.128 | 0.4310 | 1.033 | 9.977 | 11.12 | 8.326 | 2.392 | 0.1731 |

**Means with the same letter are not significantly different.**

**Table 6. Effect of nitrogen and cobalt rates applied on N, P, K, Fe, Mn, Zn, Cu and Co, status in faba bean roots (average of two seasons).**

| Treatments | | | kg fed$^{-1}$ | | | | g kg$^{-1}$ | | |
|---|---|---|---|---|---|---|---|---|---|
| N rates | Co rates | N | P | N | Fe | Mn | Zn | Cu | Co |
| 0.0 | -- | 1.167$^{d}$ | 0.086$^{d}$ | 0.107$^{d}$ | 34.34$^{d}$ | 10.34$^{d}$ | 4.383$^{d}$ | 1.136$^{d}$ | 0.076$^{d}$ |
| 7.50 | -- | 1.563$^{c}$ | 0.185$^{c}$ | 0.212$^{c}$ | 46.91$^{c}$ | 14.41$^{c}$ | 9.269$^{c}$ | 1.953$^{c}$ | 0.180$^{c}$ |
| 10.00 | -- | 1.772$^{b}$ | 0.296$^{b}$ | 0.448$^{b}$ | 66.77$^{b}$ | 20.43$^{b}$ | 15.840$^{b}$ | 3.493$^{b}$ | 0.361$^{b}$ |
| 15.00 | -- | 2.313$^{a}$ | 0.440$^{a}$ | 0.743$^{a}$ | 74.64$^{a}$ | 25.14$^{a}$ | 26.290$^{a}$ | 5.245$^{a}$ | 0.550$^{a}$ |
| LSD at 0.5 for A | | 0.05159 | 0.001153 | 0.05159 | 2.658 | 0.8686 | 0.6676 | 0.1315 | 0.001153 |
| -- | 0.00 | 1.408$^{c}$ | 0.178$^{c}$ | 0.267$^{c}$ | 47.76$^{c}$ | 14.38$^{c}$ | 10.450$^{c}$ | 2.263$^{c}$ | 0.209$^{c}$ |
| -- | 0.50 | 1.721$^{b}$ | 0.261$^{b}$ | 0.374$^{b}$ | 56.79$^{b}$ | 17.53$^{b}$ | 14.110$^{b}$ | 2.863$^{b}$ | 0.282$^{b}$ |
| -- | 1.00 | 1.983$^{a}$ | 0.317$^{a}$ | 0.492$^{a}$ | 62.43$^{a}$ | 20.83$^{a}$ | 17.270$^{a}$ | 3.743$^{a}$ | 0.384$^{a}$ |
| LSD at 0.5 for B | | 0.06704 | 0.0008654 | 0.02737 | 2.166 | 0.6748 | 0.5622 | 0.1224 | 0.0008654 |
| | 0.00 | 0.858$^{i}$ | 0.006$^{k}$ | 0.059$^{g}$ | 26.11$^{i}$ | 16.709$^{h}$ | 3.008$^{h}$ | 0.782$^{g}$ | 0.048$^{k}$ |
| control | 0.50 | 0.989$^{i}$ | 0.093$^{j}$ | 0.092$^{g}$ | 31.15$^{h}$ | 9.106$^{g}$ | 3.817$^{h}$ | 1.010$^{g}$ | 0.066$^{j}$ |
| | 1.00 | 1.655f$^{g}$ | 0.159$^{h}$ | 0.170$^{f}$ | 45.76$^{f}$ | 15.210$^{e}$ | 6.326$^{g}$ | 1.615$^{f}$ | 0.114$^{h}$ |
| | 0.00 | 1.364$^{h}$ | 0.142$^{i}$ | 0.154$^{f}$ | 40.76$^{g}$ | 12.560$^{f}$ | 7.463$^{f}$ | 1.546$^{f}$ | 0.103$^{i}$ |
| 7.50 | 0.50 | 1.737$^{ef}$ | 0.209$^{f}$ | 0.227$^{e}$ | 52.10$^{e}$ | 15.58d$^{e}$ | 9.868$^{e}$ | 2.082$^{e}$ | 0.197$^{g}$ |
| | 1.00 | 1.588$^{g}$ | 0.202$^{g}$ | 0.256$^{de}$ | 47.87$^{ef}$ | 15.080$^{e}$ | 10.480$^{e}$ | 2.229$^{e}$ | 0.240$^{f}$ |
| | 0.00 | 1.534$^{g}$ | 0.201$^{g}$ | 0.310$^{d}$ | 58.83$^{d}$ | 16.90$^{d}$ | 10.440$^{e}$ | 2.745$^{d}$ | 0.273$^{e}$ |
| 10.00 | 0.50 | 1.989$^{c}$ | 0.342$^{e}$ | 0.497$^{c}$ | 75.13$^{b}$ | 23.08$^{b}$ | 18.130$^{d}$ | 3.873$^{c}$ | 0.397$^{d}$ |
| | 1.00 | 1.794$^{de}$ | 0.344$^{d}$ | 0.538$^{c}$ | 66.33$^{c}$ | 21.310$^{c}$ | 18.930$^{d}$ | 3.862$^{c}$ | 0.412$^{c}$ |
| | 0.00 | 1.875$^{cd}$ | 0.360$^{c}$ | 0.546$^{c}$ | 65.34$^{c}$ | 21.33$^{c}$ | 20.900$^{c}$ | 3.980$^{c}$ | 0.413$^{c}$ |
| 15.00 | 0.50 | 2.169$^{b}$ | 0.398$^{b}$ | 0.678$^{b}$ | 68.80$^{c}$ | 22.36$^{bc}$ | 24.630$^{b}$ | 4.488$^{b}$ | 0.468$^{b}$ |
| | 1.00 | 2.896$^{a}$ | 0.561$^{a}$ | 1.006$^{a}$ | 89.77$^{a}$ | 31.72$^{a}$ | 33.330$^{a}$ | 7.267$^{a}$ | 0.770$^{a}$ |
| LSD at 0.5 for A X B | | 0.1341 | 0.001731 | 0.05474 | 4.331 | 1.350 | 1.124 | 0.2448 | 0.001731 |

**Means with the same letter are not significantly different.**

## CONCLOUSION

The abovementioned presentation and discussion suggested that, there was benefit effect for the application of nitrogen in companied with cobalt on productivity and nutritional status of faba bean plants. However, nitrogen the soil application at a rate of 15.0 kg N fed$^{-1}$ + foliar sprays of cobalt 1.0 mg L$^{-1}$ was for all parameters under study of faba bean grown under that condition.

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## أثر إضافة معدلات من النيتروجين و الكوبالت على محصول الفول البلدى النامى فى أرض طينية


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أقيمت تجربتان حقليتان فى الموسم الشتوى لعامى 2015/2014 و 2015/ 2016 على نباتات الفول البلدى فى محطة البحوث الزراعية بالجميزة محافظة الغربية.بهدف دراسة تأثير إضافة السماد النيتروجينى على صورة كبريتات أمونيوم 20.5% بمعدل ( صفر، 7,5، 10.0، 15.0 كجم نيتروجين فدان-1) كإضافة أرضية والكوبالت بمعدل (صفر، 0,5، 1 مليجرام لتر-1) فى صورة سلفات كوبالت رشاً على الأواق على كل من محصول الفول البلدى ومكوناتة ومحتواه من العناصر المغذية. كان التحليل الإحصائى لهذه التجربة تصميم قطاعات كاملة العشوائية للموسمين معاً. ولقد أوضحت النتائج أن محصول الحبوب والقش والجذور ووزن 100 حبة قد تأثر معنوياً بإضافة النيتروجين بمستوياتة المستخدمة تحت الدراسة وقد تحقق أعلى محصول بإضافة 15 كجم نيتروجين فدان-1 كإضافة أرضية. بينما أدى إضافة الكوبالت رشاً على الأوراق سواء بتركيز 0,5 أو 1 مليجرام لتر-1 إلى زيادة معنوية فى كل من محصول الحبوب والقش والجذور وكانت أعلى قيم متحصل عليها نتيجة عند الرش بتركيز 1 مليجرام لتر-1 كوبالت. كما أظهرت النتائج أن إضافة النيتروجين مع الكوبالت أدت إلى زيادة معنوية فى كل من محصول الحبوب والقش والجذور وكانت أعلى زيادة معنوية عند إضافة 15 كجم نتروجين فدان-1 مع رش الاوراق بالكوبالت بتركيز 1 مليجرام لتر-1. توجد زيادة معنوية فى محتوى النيتروجين والفوسفور والبوتاسيوم والحديد والزنك والنحاس با لإضافة إلى الكوبالت فى الحبوب والقش والجذور نتيجة إضافة النيتروجين بكل مستوياتة تحت الدراسة وقد تحققت أعلى زيادة عند إضافة 15 كجم نيتروجين للفدان-1. كما أدت إضافة الكوبالت رشاً على الأوراق بمستوياتة تحت الدراسة إلى زيادة معنوية ملحوظة لكل من العناصر السابقة وكانت أعلى زيادة فى محتوى هذه العناصر المدروسة نتيجة إضافة الكوبالت رشاً بتركيز 1 مليجرام لتر-1. كما أدت إضافة النيتروجين والكوبالت معاً إلى زيادة معنوية لجميع العناصر المغذية فى جميع أجزاء النبات المأخوذ . وكانت أعلى زيادة نتيجة إضافة 15 كجم نيتروجين فدان-1 مع رش الأوراق بالكوبالت بتركيز 1 مليجرام لتر-1. أدى إضافة كل من النيتروجين والكوبالت بمستوياتهم المستخدمة إلى زيادة معنوية فى تيسر النيتروجين والفوسفور والبوتاسيوم والكوبالت فى التربة وكانت أعلى زيادة نتيجة إضافة 15 كجم نيتروجين فدان-1 مع الرش بالكوبالت بتركيز 1 مليجرام لتر-1.