International Journal of PharmTech Research
CODEN (USA): IJPRIF, ISSN: 0974-4304, ISSN(Online): 2455-9563
Vol.9, No.12, pp 215-222, 2016

Influence of cobalt on Faba bean production under different nitrogen rates

Nadia Gad[1]; M.R.Abdel-Moez[1] and F. Anter[2]

[1]Plant Nutrution Dep. National Research Center, El-Behoos, Dokki, Cairo, Egypt
[2]Soils and Water Use Dep. National Research Center, El-Behoos, Dokki, Cairo, Egypt

Abstract : Two field experiments carried out to evaluate the effect of cobalt and different nitrogen doses on faba bean production. The experiments were conducted at Research and Production Station, National Research Centre, El-Nobaria Site, Beheara Governorate, Delta Egypt under drip irrigation system on 2014 and 2015 seasons.
The obtained results are summarized in the following:-
*Cobalt has a significant primitive effect on nitrogenase enzyme activity and nodulation rate especially with 100 % N followed by 75% N.
*Cobalt significantly increased faba bean growth, seeds yield as well as minerals and biochemical contents under all nitrogen rates compared with control (100% N alone).
*Cobalt with 75% N gave the greatest figures compared with 100% N alone.
*Cobalt with 50% N was no significant while with 25% N gave the lowest once.
Finally, the addition of cobalt to the soil, save 25% nitrogen fertilizer and could be reduced nitrogen environmental pollution and induced the agricultural cost for more money of farmers
Key words: faba bean – cobalt – nitrogen fertilizer.

Introduction

Faba bean (*Vicia faba L.)* is one among the most important nutritive seed legumes and widely considered as a good resource of protein and minerals. Faba bean is one of the major winter sown legume crops and has considerable importance as a low cost food rich in proteins and carbohydrates in Egypt.

Nitrogen proved to be one of the greatest influences on faba bean growth as well as seed yield quantity and its quality.

With increasing mineral fertilizers cost and questions as to their availability in future (Parr and Hornic, [1]), cobalt is an essential element for legumes due to its essentiality for micro-organisms fixing atmospheric nitrogen (Evans and Kliwer, [2]).

Cobalt was directly proportional to vitamin B_{12} content which plays an important role in enhancement fixation of atmospheric nitrogen. Cobalt is essential for growth rhizobia, the specific bacteria involved the legume nodulation and nitrogen Fixation into amino acids and protein in nitrogen fixing bacteria, the nitrogenase enzyme drive the reaction of ATP (Watson *et al*, [3]). Due *et al* [4] showed that cobalt at 8 ppm had a greatest growth parameters as well as pods and seeds yield in cowpea. Sowicki [5] reported that cobalt at 0.21 k/ha increased plant height, number of branches and leaves, leaf area index, dry weight of shoots along with pods yield of groundnut. Nasef *et al*[6] stated that cobalt gave significantly higher biomass production and seeds yield of cowpea compared with untreated plants.

Balai and Majumdar[7] showed that cobalt increased total phenol content and water potential of cowpea leaves compared with control. Jayakumar *et al* [8] stated that all minerals content of blackgram were increased with cobalt at 50 mg/kg soil, when compared with the control. Abdul Jaleel *et al* [9] added that cobalt at 50 mg/kg soil increased carotenoids, antioxidant enzymes like catalase, peroxidase and polyphenol oxidase in green gram plants compared with control.

Nadia Gad *et al* [10] found that cobalt at 12 ppm significantly increased nodulation rate, growth, pods and seeds yield, minerals and biochemical contents of faba bean seeds.

This work was carried out to elasporte further the role of cobalt and agriculture compost waste on faba bean production.

Materials 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 Blackmore[11]. Soil pH, EC, cations and anions, organic matter, $CaCO_3$, total nitrogen and available P, K, Fe, Mn, Zn, Cu were run according to Black *et al.*,[12]. Determination of soluble, available and total cobalt was determined according to method described by Cottenie *et al.*, [13]. Some physical and chemical properties of Nubaria soil are shown in Table (1)

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^1L)				**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 (Welting point), AW (Available water)

Experimental works:-

Two field experiments were conducted in the winter growing seasons, 2014 and 2015 on faba bean at Research and Production Station, National Research Centre, Cairo, Egypt to evaluate the effect of cobalt on the plant response to different rates of inorganic and organic nitrogen fertilizers.

Seeds of faba bean (*Vicia faba L.)* var. Giza Kindly obtained from Agronomy Department, ministry of Agriculture, Egypt were inoculated with selective strain of *Rhizobium leguminosarum* var. vicia prior to sown on 8,11 October 2014 and 2015 under drip irrigation system.

Experiment was consists of 8 treatments. Each treatment was represented by three plots. Each plot area was 5x3 meter, consists of three rows, calcium super phosphate (15.5%) at 200 kg/fed was added during soil preparation; 20 kg/fed ammonium sulphate (20.5%N) and 50 kg/fed potassium sulphate (48% k_2o) were added. Faba bean seedlings (at third truly leaf) were irrigated once with cobalt at 12 ppm according Nadia Gad *et al* [10].

A number of 8 treatments were concluded:-

Control (100% recommended NH_2 SO_4)
75% NH_2 SO_4
50% NH_2 SO_4 without cobalt
25% NH_2 SO_4
Control (100% recommended NH_2 SO_4)
75% NH_2 SO_4
50% NH_2 SO_4 with 12 ppm cobalt
25% NH_2 SO_4

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

Measurement nodulation parameters:-

After 50 days from sowing, nodulation rate was record i.e. number of both total and active nodules as well as its biomass. Also nitrogenase enzyme was determined according to Hardy *et al* [14].

Measurement of plant vegetative growth:

After 58 days from sowing to study the vegetative growth parameters expressed as plant height, number of branches and leaves, leaves area, root length as well as fresh and dry weights of both shoots and roots according to FAO [15].

Measurement of pods an seeds yield:-

After 90 days from sowing, pods and seeds yield and its quality such as number of pods per plant, pod length, pod width, fresh weight of 100 seeds and total yield (ton/fed). Were determined according to Gabal *et al* [16].

Measurements of Nutritional status:

In pea seeds, macronutrients (N, P and K) and micronutrients (Fe, Mn, Zn and Cu) as well as cobalt content were determined according to Cottenie *et al* [13].

Measurement of Chemical constituents:

In pea seeds, total proteins, total carbohydrates, total soluble sugars, total soluble solids as well as vitamins A and C were determined according to A.O.A.C [17].

Statistical Analysis:

All data were subjected to statistical analysis according to procedure outlined by SAS [18] computer program and means were compared by LSD method according to authors, Sendecor and Cochran [19].

Results and Discussion

Nodulation and Nitrogen fixation:-

The obtained data in Table (2) indicate that cobalt has a significant positive effect on faba bean root nodules parameters under different nitrogen levels compared with the untreated plants. Cobalt recorded the maximum faba bean nodules parameters i.e. nodules number per plant, fresh and dry weights of nodules with 100% nitrogen followed by 75% nitrogen. Reducing the level of nitrogen up to 50% nitrogen was not significant while with 25% nitrogen, cobalt gave the lowest nodulation rate after 50 days from sowing in the two seasons.

Table (2):- Faba bean 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 (nodule)	Nodules fresh weight (g)	Nodules dry weight (g)	Nitrogenase activity μ mol $_2^{CH}{}_2$ /g/h
	Without cobalt			
100	129.3	13.51	3.93	18.6
75	121.6	13.09	3.74	17.5
50	112.2	12.78	3.22	16.7
25	104.5	11.13	2.96	14.9
	With cobalt at 12 ppm			
100	153.6	15.95	4.61	21.7
75	144.9	15.09	4.23	20.4
50	132.0	13.74	3.89	18.6
25	116.2	11.19	2.94	17.0
LSD 5%	3.3	0.65	0.19	0.3

These results are in harmony with those obtained by Balai *et al* [20] who pointed that cobalt significantly improved total nodules and its dry weight, number and weight of effective nodules and root dry weight in cowpea plants compared with control plants. Data in Table (2) also reflected that cobalt can play a vital role in increasing nitrogenase enzyme activity with all nitrogen levels of faba bean root nodulation compared with control. Cobalt record the best rate of the nitrogenase enzyme activity with 100% followed by 75% nitrogen compared with the control (100% N alone). With the rate of 50% nitrogen cobalt no significantly while, with 25% nitrogen gave the lowest once. These results are agree with those obtained by Epstein [21] who showed that the co-enzyme cabalamin has cobalt (111) as a metal component, cheleated to four nitrogen atoms at the center of prophyrin structure similar to that of iron in hemin. In rhizobium species, enzymes dependents with cobalt induced their activities are primarily responsible for the relationship to nodulation and nitrogen fixation in legumes.

Vegetative growth:

Faba bean growth parameters as affected by cobalt and nitrogen levels after 60 days from sowing are given in Table (3). Data indicate that cobalt at 12 ppm has a significant promotive effect on all growth parameters such as plant height, number of branches and leaves per plant, leaf area index, root length as well as shoot and root biomass under different nitrogen levels compared with untreated plants. It is clear that cobalt enhance all faba bean growth parameters especially with 100% and 75% nitrogen compared with the control (100% N alone).

As nitrogen level was reduced, cobalt promotive effect reduced. Cobalt with 25% nitrogen resulted the lowest figures. These results are a good agreement with those obtained by Nadia Gad [22] who found that cobalt gave the greatest figures of groundnut growth parameters especially with 100% N followed by 75% while 50% N cobalt was not significant, cobalt resulted the lowest once with 25% N compared with control (100% N alone).

Table (3): Faba bean growth parameters as affected by cobalt under different nitrogen levels after 60 days from sowing (Means of two seasons).

Nitrogen treatments (%)	Plant hight (cm)	Number/plant		Leaves area index (cm^2)	Root Length (cm)	Dry weight (g)	
		Branches	Leaves			Shoot	Root
		Without cobalt					
100	128.0	8.1	58.7	2179	12.6	46.8	4.67
75	125.5	7.0	57.2	2134	11.9	45.1	3.89
50	123.0	5.5	49.6	1288	10.3	40.9	3.34
25	119.6	4.3	42.9	1134	8.82	35.1	2.19
	With cobalt at 12 ppm						
100	134.2	11.1	62.5	2387	16.7	54.8	6.59
75	131.4	9.9	61.9	2345	14.9	53.0	5.71
50	127.3	7.62	53.8	2330	12.8	47.4	4.62
25	122.7	6.11	49.4	1762	10.6	40.9	2.98
LSD 5%	**2.5**	**1.8**	**1.5**	**15.0**	**1.6**	**1.8**	**1.79**

Yield characteristics:-

Obtained results in Table (4) show that cobalt significantly increase all studied yield parameters of faba bean i.e., pods number per plant, pods weight per plant, weight of 100 seeds, seeds yield per plant, seeds yield per feddan. Cobalt increase all faba bean yield parameters under different nitrogen rates comparison with untreated plants. Cobalt increase faba bean seeds yield with 75% N about by 118.22% compared with control (100% N alone). Cobalt also saved 25% nitrogen fertilizer.

Table (4): Faba bean seeds yield as affected by cobalt under different nitrogen levels (Means of two seasons).

Nitrogen treatments(%)	Number of pods/plant	Pod weight per plant(g)	Seeds yield per plant(g)	Seeds yield(kg/fed)
	Without cobalt			
100	22.1	94.6	105.9	847.2
75	18.2	85.7	94.5	756.0
50	13.2	70.5	83.7	669.6
25	9.82	61.7	72.3	578.4
	With Cobalt at 12 ppm			
100	32.5	104.2	128.8	1030.4
75	28.3	96.7	125.2	1001.6
50	21.5	85.9	104.3	834.4
25	18.5	71.6	86.9	695.2
LSD 5%	3.9	7.5	3.6	28.3

According to Due et al[4] cobalt had a highest pods and seeds yield in cowpea compared with control. Abdul Jaleel et al[9,23] added that cobalt addition in soil increased all growth parameters along with yield parameters such as seedling vigor, number and weight of both pods and seeds yield in green gram (*Vigno radiate L.*) and maize (*Zea maize L.*) plants.

Nutritional Status:-

The data concerning the effect of cobalt on nutritional contents of faba bean are given in Table (5). Data reveal that cobalt has a synergistic effect on minerals composition of faba bean seeds under different nitrogen rates compared with control (100% N alone).

Nitrogen, p and K content:-

Data in Table (5) show that cobalt significantly increased the content of N, P and K in faba bean seeds with all nitrogen rates. Cobalt gave the maximum values with 100% N followed by 75% N. With nitrogen rate at 50% cobalt was no significant while with 25% N gave the lowest figures. These data are in harmony with those obtained by Jana et al[24] who found that cobalt significantly increased N, P and K content in groundnut seeds compared with untreated plants.

Table (5): Faba bean seeds minerals composition as affected by cobalt under different nitrogen levels (Means of two seasons).

Nitrogen treatments (%)	Macronutrients (%)			Micronutrients (ppm)				Cpbalt (ppm)
	N	P	K	Mn	Zn	Cu	Fe	
	Without cobalt							
100	3.92	0.192	1.81	36.3	29.2	23.9	168.4	0.68
75	3.71	0.183	1.76	32.9	26.8	21.2	168.3	0.68
50	3.17	0.174	1.70	29.8	24.5	19.1	167.0	0.67
25	2.88	0.169	1.66	22.92	21.4	16.5	167.0	0.67
	With Cobalt at 12 ppm							
100	4.65	0.198	1.86	39.0	33.0	28.5	163.5	7.31
75	4.44	0.191	1.82	36.7	31.2	26.0	160.0	7.11
50	3.81	0.186	1.75	33.4	28.8	23.7	158.3	6.82
25	3.07	0.174	1.69	28.3	25.6	21.3	156.1	6.23
LSD 5%	0.11	0.2	0.5	1.4	1.2	1.1	1.2	0.21

Manganese, Zn and Cu:-

Data in Table (5) also indicate that cobalt had a beneficial effect on Mn, Zn and Cu content in Faba bean seeds cinder all nitrogen rates. The highest values with 100% N followed by 75% N. The content of Mn, Zn and Cu record the high levels with 75% N with cobalt comparison with 100% N alone. Under 50% N, cobalt was no significant However, cobalt with 25% N gave the lowest once. The results reveal as mentioned by Nadia Gad et al [25] who stated that cobalt significantly increased Mn, Zn and Cu Content in soybean seeds.

Iron content:-

Data in Table (5) show that with the increasing cobalt content in faba bean seeds iron was reduced. These results are in good agreement with those found by Blaylock et al [26] who found that cobalt addition in plant growth media in progressive depression effect on iron in soybean plants.

Cobalt status:-

El-Kobbia and Osman[27] pointed that there was evidence that when plant roots absorb water, soil containing cobalt moves from the non-rhizosphere soil towards roots by mass flow. Data in Table (5) indicate cobalt content in faba bean seeds increased with cobalt addition in plant media. The mentioned by Nadia Gad [28].

Chemical constituents:-

The data in Table (6) reveal that cobalt has a significant positive effect on chemical content of faba bean seeds i.e., total protein, total carbohydrates and total soluble sugars percentage with all nitrogen doses.

Table (6): Faba bean seeds chemical constituents as affected by cobalt under different nitrogen levels (Means of two seasons).

Nitrogen treatments	Total Proteins	Total Carbohydrates	Total soluble Sugars	Vitamin (A)
%				(M/100g)
Without cobalt				
100	24.50	55.7	5.21	8.11
75	23.19	54.9	4.89	7.87
50	19.81	52.3	4.79	7.08
25	18.00	50.5	3.68	6.89
With cobalt at 12 ppm				
100	29.06	57.0	5.72	8.71
75	27.75	55.9	5.39	8.26
50	23.81	53.6	4.91	7.89
25	19.19	52.0	4.03	7.14
LSD 5%	1.62	1.1	0.18	0.3

Cobalt with 75% nitrogen resulted the highest figures compared with 100% nitrogen alone. Those reported by Vijayarenagan *et al* [29] who found that cobalt at 50 mg/kg soil had a beneficial values of biochemical of groundnut seeds like total proteins, total carbohydrates, total soluble sugars, starch and amino acids when compared with untreated plants.

Conclusion:-

Cobalt at 12 ppm significantly increases all growth and yield parameters in faba bean under nitrogen doses. Cobalt gave the maximum values especially with 100% N followed by 75%. Cobalt with 75% N gave the greatest nodulation rates, growth, seeds yield, minerals composition as well as chemical constituents in seeds. Cobalt enhance seeds quantity and quality compared with100% N alone. Cobalt saved about 25% of the recommended nitrogen fertilizer dose.

References

1. Parr, J.F and S.B. Hornick. 1990. Recent developments in alternative agriculture in the United States. In Proc. of Intl. Conf. on Kyusei Nature Farming, October 17-21, 1989, Khon Kaen University, Khon Kaen, Thailand
2. Evans, H.J. and M.Kliwer (1964). Vitamin B compounds in relation to the requirements of cobalt for higher plants and nitrogen fixing organisms. Annals of New York Academic Scinsce.2: 732-755
3. Watson, R.J.; R. Hets; T. Martin and M. Savard (2001). Sino rhizobium meliloti cells require biotin and eithercobalt methionine for growth. Applied and Environmental Microbiology. 86(7):376-3770
4. Due, I.S.; R.L.Sharma; and A.V. Rao (1999). Effect of foliar application of molybdenum and cobalt on soybean Rhizobium symbiosis. Legume Research. 1:97-100
5. Sowicki, B. (2000). The influence of cobalt fertilization on quantity and quality of hay from dried meadow using various NPK doses. Annales Universatatis. Marae curie Sklodowsko Sectio-e. Agric. 54:97-104
6. Nasef, M.A.; A.M. Abd El-Hameed; H.M. Salem and A.F. Abd El-Hamide (2008). Efficiency of applied rates and methods of cobalt on growth, yield and elemental composition of peanut plants growth on a sandy soil. Annals of Agricultural Science, Moshtohor 42 (2): 850-851
7. Balai, C. M. and S.P. Majumdar (2007). Metabolites content and water relations of cowpea [*Vigna unguiculata* (*L.*) Walp] as influenced by different levels of compaction, potassium and cobalt. Current Agriculture. 31 (1/2):47-53. 17
8. 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

9. Abdul Jaleel, C.; K. J; Z. Chang-Xing and M.M. Jayakumar Azooz.n (2009b). Antioxidant potentials protect *Vigna mungo (L.*) Wilezek plants from soil cobalt stress and improve growth and pigment composition. Plant Omies Journal 2(3): 120-126
10. Nadia Gad; Fatma H. Abd el Zaher; H.K. Abd El Maksoud and Abd El-Moez (2011). Response of faba bean (*Vicia faba L.)* to cobalt amendments and nitrogen fertilization. The African J. of plant science and Biotechnology 5 (1): 41 - 45
11. 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
12. 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
13. 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
14. Hardy, R.W.F.; R.D. Holsten.;E.K.Jackson and R.C. Burns (1968). The Acetylene-Ethylene Assay for N2-Fixation: Laboratory and field Evaluation. Plant Physiology. (43)1185-1207
15. FAO, (1980). Soil and plant testing as a basis of fertilizer recommendations. Soil Bull., 3812
16. Gabal, M.R.; I.M. Abd-Allah; F.M. Hass and S. Hassannen, (1984). Evaluation of some American tomato cultivars grown for early summer production in Egypt, Annals of Agriculture Science Moshtohor., 22: 487-500
17. A.O.A.C., (1995). Method of analysis. Association of Official Agriculture Chemists. 16th Ed., Washington, D.C.USA
18. SAS. (1996). Statistical analysis system, SAS users' guide: statistics. SAS Institute Inc., Edition, Cary, NC
19. Snedecor, G.W. and W.G. Cochran, (1980). Statistical Analysis Methods. 6th Ed. Iowa State Univ. Press. Ames., Iowa, USA
20. Balai, C. M. and S.P. Majumdar and B. L. Kumawat (2005b). Effect of soil compaction, potassium and cobalt on growth and yield of cowpea. Indian Journal of Pulses Research. 18 (1): 38-39
21. Epstein, E. (1972). "Mineral Nutrition of plants". Principles and perspectives, wiley and sons, pp. 29-49
22. Nadia Gad (2012). Role and importance of Cobalt nutrition on groundnut (*Arachis hypogaea*).World Applied Sciences Journal 20 (3): 359-367
23. Abdul Jaleel, C.; K. J; Z. Chang-Xing and M.Iqbal (2009a). Low Concentration of Cobalt Increases Growth. Biochemical Constituents, Mineral Status and Yield in Zea Mays, Journal of Scientific Research 1 (1): 128-137
24. Jana P.K.; S. Karmakar; Ghatak; A Naybri; G. Souds; A.K. Mukher and B.K. Saren (1994). Effect of cobalt and rhizobium on yield, oil content and nutrient content and nutrient concentration in irrigated cumme groundnut. Indian Journal of Agriculture Science. 64:630-632
25. Nadia Gad; Abd El-Moez; Eman E. Aziz; Lyazzat Bckbyeva; Idres Hamad Atitaalla and Misni Surif (2014). Influence of cobalt on soybean growth and production under different levels of nitrogen.Research Article CODEN (USA): IJPLCP
26. Blaylock, A. D.; T.D. Daivis; V.D. Jolly and R. H. Walser (1995). Influnce of cobalt and iron on photosynthesis, chlorophyll and nutrients content in regreening chlorotic tomatoes and soyabeans. Journal of Plant Nutrition. 8:823-838
27. El-Kobbia, T. and A. Osman (1987). Salinity and cobalt interaction in tomato plants. Soil Science and Rural Sociology. 74: 103-115
28. Nadia Gad (2006). Increasing the efficiency of nitrogen fertilization through cobalt applucation to pea plant. Research Journal of Agriculure and Biological Sciences. 2(6): 433-442
29. Vijayarengan, P.; C. Abdul Jaleel; Z. Chang-Xing; K. Jayakumar and M.M. Azooz. (2009). Biochemical Variations in Groundnut under Cobalt Application. Global Journal of Molecular Sciences 4(1): 19-22

*****