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Improvement of pea (*Pisum sativum L.*) Production by optimization of Cobalt under different organic Fertilizers

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Abstract : Field experiments were carried out, at Research and Production Station, NRC, El-Nobaria, Beheara Governorate, Egypt, in two successive seasons (2013-2014) to assess the elemental cobalt role companied with different organic fertilizers on nodules; growth characters, yield components and quality of pea plants.
The obtained results are summarized in the following:-
* Increased nitrogenase activity associated with Co treatments, which was parallel and related to enhancement nodules number and weights and its efficiency.
* The superior pea growth and yield parameters were attained in plants which supplied with cobalt at 8 ppm and chicken manure.
* Chicken manure was superior to improve all studied parameters followed by farm yard manure, while compost of wadi el-Nile was the lowest ones.
* Application Co at 8 ppm to all studied organic fertilizers enhancing pea growth, yield and its quality.
*Organic fertilizers had a positively decreases soil pH and increase so increasing availability of cobalt and micronutrients was expected, cobalt help plants to tolerate the newly reclaimed soil conditions
Keywords : Pea, Cobalt, organic fertilizers, growth characters, yield quality.

Introduction

Pea (*Pisum sativum L.*) is considered one of the most important crops in winter.

Cobalt is an beneficial element for plant growth. In higher plants, moreover, cobalt is an essential element for legumes due its essentiality for micro-organisms fixing atmospheric nitrogen (Evans and kliwer [1]).

In plants other legumes, cobalt promoted many developmental processes including stem and cleoptiles elongation opening of hypocotyls hooks, leaf expansion and bud development (Howell and Skoog, [2]). Cobalt is an essential element for the thynthesis of vitamin B_{12} which is required for human and animal nutrition (Smith, [3]). Application of cobalt at 0.21 kg/ha which improved nodules number and its dry weight per plants in addition to leghemoglobin content in peanut roots[4]. Whereas, [5,6] demonstrated that addition of Co enhanced total nodules number and dry weight, number and dry weight of effective nodules and root dry weight of pea. In view of point, [7] pointed out that cobalt at 8 ppm had highest values of fresh and dry weights for both shoots and roots in addition to pods and seeds yield quantity and quality of peas relative to control and other rates of cobalt.

Soils of Egypt are poor in organic matter exceeding 2% 8, therefore to reduce about 82 million tons applied annually [9]. From the other side, increasing the cost of mineral fertilizers and questions as to their future

availability, there is a great interest in organic recycling to improve soil fertility and productivity. Abou El-Seoud [10] reported that intensive compost application to sandy soil significantly increased both dry matter production in sepals and number of fruits. Addition of 8 ppm cobalt in Cowpea plant media saved about 33% of the added organic fertilizer [11]. They added that Co also improved the contents of macronutrients (N, P and K) and micronutrients (Fe, Mn and Zn). Nadia Gad and Nagwa Hassan[12] found that, the optimization of tomato growth and yield parameters were attained at 7.5 Co ppm combined with chicken manure. Cobalt with all organic fertilizers enhancing tomato growth, yield, nutrients status and tomato fruits quality. So, this work aimed to study the effect of cobalt and different organic fertilizer sources in processes of peas growth, yield quantity and quality in sandy soils.

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 [13]. 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.*,[14]. Determination of soluble, available and total cobalt was determined according to method described by Cottenie *et al.*, [15]. 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 ($meq^{-1}L$)				**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 (Welting point), AW (Available water).

Experimental works:-

Two field experiments were carried out at the Research and production station, Nubaria site, National Research Centre, Beheara Governorate, Egypt, under drip Irrigation system during winter 2014 and 2015 seasons. Seeds of pea (*Pisum Sativum L.*) were inoculate prior to sowing with a specific strain of rhizobium leguminosarum biovar viciae. Seeds of pea were sown during winter seasons of 2014, 2015, February 25th and 27.

A number of 8 treatments were concluded:-

1. Control: received only recommended doses by Ministry of Agriculture of mineral fertilizers i.e. 150 kg/fed; supper phosphate (15.5% $p_2\ O_2$), 100 kg/fed; ammonium nitrate (33.5% N0) and 100 kg/fed potassium sulphate (48% k_2o).
2. Chiken manure (33.5 N unit)
3. Farmyard manure (33.5 N unit)
4. Wadi El-Nile Compost (33.5 N unit)

5. Control (recommended NPK) + 8 ppm cobalt
6. Chiken manure (33.5 N unit) + 8 ppm cobalt
7. Farmyard manure (33.5 N unit) + 8 ppm cobalt
8. Wadi El-Nile Compost (33.5 N unit) + 8 ppm cobalt

Each treatment was represented by 3 plots. Each plot area 5x3 meter, consisting of three rows.

Table (2): Some properties of different organic fertilizer sources used in the studies experiments.

Organic Source	O.M (%)	Total N (%)	C/N ratio	pH (1:25)	EC dsm^{-1}	Available nutrients (%)		DTPA- extractable (ppm)			
Chicken manure	33.0	2.96	7.07	6.40	8.85	0.72	0.93	564	36.8	28.2	34.7
Farmyard manure	32.2	2.81	6.66	6.23	8.53	0.65	0.86	516	32.0	25.0	31.2
Wadi El-Nile compost	25.3	1.89	7.78	6.01	5.36	0.59	0.71	480	26.0	20.1	25.1

Measurement nodulation parameters:- After 50 days from sown nodulation rate was record i.e. number of both total and active nodules as well as its biomass. Also, nitrogenase was determined according to Hardy et al [16].

Measurement of plant vegetative growth: Samples were taken 60 days after germination 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 [17].

Measurement of pods an seeds yield:- After 90 days from sowing, pods, 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* [18].

Measurements of Natritional 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** [15].

Measurement of Chemical constituents:- In pea seeds, total proteins, total carbohydrates, mono sugars as well as total soluble solids, vitamins A and C were determined according to A.O.A.C [19].

Statistical Analysis:- All data were subjected to statistical analysis according to procedure outlined by SAS [20] computer program and means were compared by LSD method according to authors, Sendecor and Cochran [21].

Results and Discussions

Nodulation Parameters:-

Data presented in Table (3) reveal that all treatments can be arranged in decreasing order as follows: Chicken manure > Farmyard manure > NPK as recommended > Wadiy El-Nile compost. The lowest nodulation parameters of pea were obtained by Wady El-Nile compost. Same results was obtained by [22].

Table (3): Nodulation rate and Nitrogenase Enzyme of pea roots as affected by cobalt and different organic fertilizers (Means of two seasons)

Treatments	Active nodules		Total nodules		Nitrogenase $\mu molC_2H_2/g/h$
	Number	Fresh weight (g)	Number	Fresh weight (g)	
Without cobalt					
Control	26	2.26	67	5.57	16.1
Chicken manure	41	3.59	82	6.91	17.5
Farmyard manure	30	2.67	76	6.68	16.9
Wadi El-Nil Compost	18	1.75	54	5.38	15.4
With cobalt (8 ppm)					
Control	33	2.92	78	6.81	18.2
Chicken manure	50	4.40	113	9.54	19.7
Farmyard manure	42	3.79	96	8.47	19.3
Wadi El-Nil Compost	28	2.77	69	5.70	17.7
LSD5%	1.0	0.2	2.0	0.23	0.2

Data indicate that the addition of cobalt at 8 ppm to pea plant growth media significantly increase pea nodules numbers and weights with all organic fertilizers. These results are good agreement with those obtained by [7] who found that cobalt improved pea nodules formation process as clearly seen in the Table with all organic fertilizers compared with control (recommended N, P and K). Cobalt also, enhanced the number and weight of effective nodules per plant with the studied organic fertilizers compared with untreated plants. These results are agree with those found by [23].

Nasef et al [24] added that cobalt at 0.16 mg g^{-1-} level showed significantly higher nodule number and weight, nodule N Concentration, leghaemoglobin content, total biomass production and seeds yield of peanut compared with untreated plants.

Vegetative growth: Data presented in Table (4) show the effected of cobalt and different organic fertilizers on pea growth parameters such as plant hight, number of branches and leaves, leaves area index, root length as well as fresh and dry weights of both shoots and roots.

Table (4): Pea growth parameters as affected by cobalt and different organic fertilizers (Means of two seasons)

Treatments	Plant height (cm)	Number/plant		Leaves area (cm^2)	Root Length (cm)	Fresh weight (g)		Dry weight (g)	
		Branches	Leaves			Shoot	Root	Shoot	Root
		Without cobalt							
Control (NPK)	23.9	6	11	184	9.3	14.6	3.74	3.72	0.71
Chicken manure	31.6	7	13	208	11.5	17.7	5.41	4.45	2.44
Farmyard manure	27.0	6	12	195	10.2	15.5	4.95	3.86	2.13
Wadi El-Nile Compost	20.5	5	9	176	7.6	10.8	2.89	2.77	1.37
	With cobalt (8 ppm)								
Control (NPK)	28.0	7	13	205	11.9	17.5	4.95	4.47	2.17
Chicken manure	36.8	8	14	234	14.7	21.6	5.76	5.36	2.75
Farmyard manure	32.2	8	13	217	13.2	18.8	5.45	4.79	2.49
Wadi El-Nile Compost	25.1	6	10	192	9.8	12.9	3.34	3.65	1.69
LSD5%	1.2	1.0	1.0	3.0	0.6	0.2	0.4	0.7	0.4

The superior pea growth parameters were recorded by plants which supplied with chicken manure. All treatments can be arranged in decreasing order as follows: chicken manure > Farmyard manure > NPK as recommended > Wadiy El-Nile compost. Data in Table (4) illustrated that, it is clear to notice the positive effect of organic fertilizer

It is obvious that chichen and farmyard manure had a synergistic effect on both fresh and dry weights of pea shoots and roots. Wadi El-Nile compost gave the lowest ones. Eloit [25]supported resulted data, who reported that animal manures have been used for plant production effectively for centuries. Chicken manure has long been recognized as perhaps the most desirable of these natural fertilizers because of its high nitrogen content. Data in Table (4) showed a significant beneficial effect on shoot and root fresh and dry weights with all organic fertilizers sources as a result of Co treated. Data in Table (4) clearly indicate that, supplementing plant media with 8 ppm cobalt with all organic fertilizers as well as control (mineral N,P and K) enhance plant growth which was reflect on plant growth especially dry matter content. Good agreement of data was obtained with those attained by [26] who reported that, organic fertilizers decreased soil PH and increased the availability of cobalt. Cobalt improves olive growth parameters. Bibak [27] added that, winter wheat which treated with cobalt and farmyard manure responses the higher growth compared with untreated ones.

Yield characteristics:-

Data presented in Table (5) clearly indicate that chicken and farmyard manure significantly increase all pea yield parameters such as number of pods per plant, pod length, pod width, pod thickness, fresh weight of 100 seeds and total yield (ton/fed) Chicken and farmyard manure significantly increased total yield of peas 17.12 and 12.89% respectively while Wadi El-Nile compost gave the lowest one as relative calculated as percentage from control. These results are in harmony with those obtained by [28] who found that chicken manure improve the growth, lettuce yield and its quality as well as human health compared with untreated plants [27] mentioned that whereas the treatment of the winter wheat plants grown in sandy loam soil supplied with N increased plant growth and yield, responses were higher when receiving farmyard manure.

Table (5): pea yield parameters as affected by cobalt and different organic fertilizers (Means of two seasons)

Fertilizers treatment	Number of pods/plant	Pod length (cm)	Pod width (cm)	Pod thickness (cm)	Fresh weight of 100 seeds (g)	Total yield (ton/fed)
Without cobalt						
Control (NPK)	9.2	7.6	0.7	1.04	49.3	4.235
Chicken manure	12.9	9.2	0.9	1.15	55.7	5.768
Farmyard manure	11.6	8.1	0.8	1.13	52.6	5.281
Wadi El-Nile Compost	7.2	6.0	0.5	0.92	43.9	3.456
With cobalt (8 ppm)						
Control (NPK)	11.6	9.7	0.8	1.16	51.0	5.481
Chicken manure	16.5	12.2	1.01	1.17	56.6	7.983
Farmyard manure	14.4	11.0	0.9	1.15	53.8	7.227
Wadi El-Nile Compost	9.8	7.4	0.6	1.12	45.7	4.435
LSD5%	0.6	0.2	0.3	0.2	1.1	0.29

Data presented in Table (5) also show that cobalt gave a significant promotive effect on all yield parameters of pea yield with different organic fertilizers as well as control plants which treated with recommended NPK fertilizers. It is evident that cobalt addition increased pea yield to 38.40 % with chicken manure, 36.85% with farmyard manure, 29.42% with recommended mineral N, P and K and 28.33% with Wadi El-Nile compost. These results are agrees with those obtained [29] who found that cobalt at 50 mg/kg soil increased number of nodules, growth and yield parameters of groundnut plants compared with the control. Nadia Gad *et al* [30] reported that cobalt had a pronounced effect on all studied yield characters of cowpea.

Confirm these results woith [31] who stated that cobalt application levels significantly increase all growth and yield parameters of fenugreek plants compared with control.

Nutritional status:-

Data in Table (6) illustrated that application of chicken manure recorded the highest content of both macronutrients and micronutrients followed by farmyard one. Wadi El-Nile compost gave the lowest figures. These results are in harmony with those obtained by [32] who show that manures supply other nutrients and serve as soil amendments by adding organic matter.

Table (6): Nutritional states of pea seeds as affected by cobalt and different organic fertilizers (Means of two seasons)

Fertilizers treatment	Macronutrients (%)			Micronutrients (ppm)				Cpbalt (ppm)
	N	P	K	Mn	Zn	Cu	Fe	
	Without cobalt							
Control (NPK)	2.88	0.321	1.24	20.3	16.4	22.0	169	0.69
Chicken manure	3.28	0.442	1.51	22.5	18.7	26.2	153	0.98
Farmyard manure	3.11	0.375	1.36	21.0	17.2	24.5	139	0.78
Wadi El-Nile Compost	1.88	0.211	0.96	16.5	14.0	19.3	122	0.62
	With Cobalt (8 ppm)							
Control (NPK)	3.14	0.354	1.36	21.5	19.5	24.6	161	1.86
Chicken manure	4.24	0.471	1.78	26.8	23.5	28.5	148	3.68
Farmyard manure	4.08	0.418	1.57	23.6	21.8	26.2	131	3.35
Wadi El-Nile Compost	2.67	0.242	1.18	18.0	16.2	20.1	114	1.93
LSD 5%	0.17	0.31	0.6	1.2	0.2	0.9	3.0	0.2

Arisha and Bradisi [33] adding organic matter in soil improves moisture and nutrients retention and soil physical properties. Obtained data (Table 6) clearly indicate that cobalt has a maximum content of the studied macronutrients in pea seeds comparing with both chicken and farmyared manure followed by control (mineral N,P and K). Meanwhile Wadi El-Nile compost gave the lowest ones. The results reveal, as expected and as mentioned [11] , who mentioned that cobalt at 8 ppm maximize macronutrients content in cowpea plants under different organic fertilizers.

Data in Table (7) revealed that cobalt improved micronutrients content and associated with the highest values of Mn, Zn and Cu of pea seeds especially under chicken and farmyard manure. Wadi El Nile compost gave the lowest ones. These results are agree with those obtained by [34] who found that all minerals composition of black gram were increased with cobalt at 50 mg/kg soil. Data also indicate certain antagonistic relationships between cobalt and iron [35].

Table (7): Pea chemical constituents as affected by of cobalt and organic fertilizers (Means of two seasons).

Fertilizers treatments	Total Proteins	Total soluble Solids	Total Carbohydrates	Total soluble Sugars	Vitamin (C)	Vitamin (A)
	%				(mg/100 g FW)	
Without cobalt						
Control (NPK)	18.0	19.4	17.2	10.2	3.66	1.64
Chicken manure	20.5	21.6	22.0	13.5	4.51	2.82
Farmyard manure	19.4	20.4	19.5	12.0	4.12	2.20
Wadi El-Nile Compost	11.8	13.0	14.7	9.66	2.85	1.41
With cobalt (8 ppm)						
Control (NPK)	19.6	21.0	19.3	11.0	5.99	3.94
Chicken manure	26.5	23.8	23.5	15.1	7.41	4.98
Farmyard manure	25.5	22.2	21.2	13.6	6.89	4.43
Wadi El-Nile Compost	16.7	14.7	16.0	10.8	3.97	2.60
LSD 5%	1.3	0.6	1.2	0.6	1.48	0.34

Cobalt content in pea seeds which treated with cobalt higher than untreated plants. These results are in harmony with those obtained by [27] who found that winter wheat growing on sandy soil treated with farmyard manure increased cobalt uptake by crops and the highest cobalt content was noticed with chicken manure (3.68 ppm). Young [36] explained that on base that the daily cobalt requirement for human nutrition could reach 8 ppm depending on cobalt levels in the local supply of drinking water without health hazard.

Chemical Constituents:-

Similar responses of pea seeds chemical constituents to different organic fertilizers. Cobalt addition to pea growing media enhancement the chemical constituents of seeds such as total proteins, total soluble solids, total carbohydrates and total soluble sugars as well as vitamins "A" and "C". These results are in agreement with those obtained by **[12]** who showed that cobalt addition with all organic fertilizers improves tomato fruits chemical constituents. Griffiths and Lunec [37] added that, for human high vitamin "C" dietary intake correlates with reduced gastric cancer risk. Vitamin "A" is an antioxidant and its essential to human growth normal physiological functions, health of the skin as well as mucous membranes.

Conclusion

Cobalt has a significant effect of pea plant growth and yield compared with control. Cobalt at 8 ppm gave the maximum values of pea growth, seeds yield, nutritional status and chemical constituents especially with chicken and farmyard manure.

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