



Effect of Bio-Organic Fertilizers on Faba bean Growth, Yield and Soil Health

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Abstract

Field experiments were carried out during two successive winter seasons of 2018/2019 and 2019/2020 in a sandy soil to evaluate the effect of bio-organic fertilizers on growth, yield of faba bean varieties cultivated in a newly reclaimed and soil health. Varieties of three faba bean were used as main plot, compost and *Rhizobium leguminosarium* were used individually or mixed as sub plot, recommended nitrogen rate (RN) used as control. The obtained results revealed that a significant variance among varieties with all parameters investigated, Nobarria 3 recorded the highest values of plant height in the two seasons. On the other hand,

Giza 843 variety recorded the lowest values at the two seasons. The highest values of plant height were recorded by using mixed fertilizers plus 75% MF. Likewise, Giza 716 give the highest values in chlorophyll content in two seasons. Nobarria 3 give the highest yield 1297Kg/ fed followed by Giza 843 then Giza 716, and the highest values were obtained with mixed amendments of 2.5 compost +R. *leguminosarium* + 75% MF. Soil health was determined by dehydrogenase activity and CO₂ evaluation in the Rhizosphere soil. The highest values were obtained with mixed amendments compared to control and other treatments.

Key words: Soil health, dehydrogenase activity, *Rhizobium leguminosarium*.

الملخص

أجريت تجارب حقالية خلال موسمي شتاء متتاليين ٢٠١٩/٢٠١٨ و ٢٠٢٠/٢٠١٩ في تربة رملية لتقييم تأثير التسميد الحيوي بريزوبيا البقوليات والسماد المعدني ٧٥٪ من الموصى به والكمبوست العضوي بمعدل ٢,٥ طن للفدان والتفاعل (التداخلي) بينها مقارنة بالجرعة الكاملة من السماد المعدني حسب التوصيات علي ثلاثة اصناف من الفول البلدي من حيث المحصول والمحتوي من العناصر المغذية . تم استخدام أصناف من ثلاث حبات من الفول كعامل رئيسي ، كما تم استخدام السماد العضوي و *Rhizobium leguminosarium* بشكل فردي أو مختلط كعامل فرعي، معدل النيتروجين الموصى به كنترول.

أوضحت النتائج المتحصل عليها وجود تباين معنوي بين الأصناف مع جميع المتغيرات التي تم فحصها ، سجلت نوبارية ٣ أعلى قيم لارتفاع النبات في الموسمين. من ناحية أخرى سجل صنف جيزة ٨٤٣ أقل القيم في الموسمين. تم تسجيل أعلى قيم لارتفاع النبات باستخدام الأسمدة المختلطة بالإضافة إلى ٧٥٪ MF. وبالمثل ، أعطت جيزة ٧١٦ أعلى القيم في محتوى الكلوروفيل في موسمين. أعطت النوبارية ٣ أعلى محصول ١٢٩٧ كجم / فدان يليها

جيزة ٨٤٣ ثم جيزة ٧١٦ وأعلى القيم كانت مع تعديلات مختلطة ٢,٥ كمبوست + Rhizobium + leguminosarium ٧٥٪ MF. تم تحديد صحة التربة من خلال نشاط نازعة الهيدروجين وتقييم ثاني أكسيد الكربون في تربة ريزوسفير. تم الحصول على أعلى القيم مع التعديلات المختلطة مقارنة بمعاملة المقارنة والمعاملات الأخرى.

الكلمات الدالة : التسميد العضوي- التسميد الحيوي – الفول البلدي - صحة التربة

ABSTRACT

Low soil fertility was one of the major factors limiting plant productivity, while, with extending in cultivating areas of crops particularly in sandy soil, so, there is more attention for using organic amendments and biofertilizers, whereas, there is a strong relationship between soil organic matter content and productivity. Continuous use of inorganic fertilization in the agriculture production system for prolonged periods to compensate the used nutrients affected the environment, harm human health, leads to the deterioration of soil physical and chemical characteristics particularly fertility thereby limiting the organic matter in the soil, affecting the nutritional value of products, and could lead to the accumulation of heavy metals in plant tissues (Ge *et al*, 2018). Due to rapid increase of world population which expected reach to 9 billion by 2050 and 12 billion by 2100, there is dramatically increasing of food and agricultural commodities, while, food demand than available production (Food and Agriculture Organization (FAO), 2017).

Chemical fertilizers cause a series of environmental problems, such as loss of soil nutrients, soil degradation, and reducing beneficial microorganisms (Parajuli *et al*, 2019). Organic and Bio-fertilizers such as Compost, Vermicompost, Biochar, Humic substances, Farm yard manure (FYM), *Azotobacter*, *Azospirillum*, Vascular arbuscular mycorrhiza (VAM), Growth Promoting Rhizobacteria (PGR), are being an essential component of nutrient management for all crops, on one hand, they improve the soil biodiversity which is very important to preserve soil health. Biofertilizers can be an effective approach to minimize chemical fertilizer sources and ultimately develop soil fertility. (Naher *et al.*, 2016). Using bio and organic fertilizers considered a key tool for sustainable horticulture crops, it offers improving soil health, increasing crops, and enhancing fruit quality, minimizing costs, and sustains natural resources (Hazarika and Aheibam, 2019).

Mikael *et al.*, (2021) Using of bio and organic fertilization to reduce mineral nitrogen fertilizer and improve sakha 108 rice cultivar productivity. They found that, the integration among mineral, organic and bio fertilization of T5 (110kg N/ha + 5 t/ha poultry manure + 600 g/ha N-fixing anabaena) gave the maximum values of tillers number m⁻², days to heading, dry matter accumulation, flag leaf chlorophyll content, flag leaf area, leaf area index, panicles number m⁻², panicle weight, 100-grain weight, grain yield, straw yield, milling percentage and grain protein content.

The objective of this study is to evaluate the response of Egyptian faba bean cultivars (Nubaria, Giza 843 and Giza 716) to reducing chemical fertilizer by using organic and

biofertilizers inoculation with *Rhizobium leguminosurm* on plant growth and bacterial activities in Rhizosphere soil and yield of faba bean crop.

Materials and Methods

A field experiments were conducted at the Research Station of the Sadat City University in Egypt. (30°2' 41.185" N and 31°14' 8.1625" E) during (2018 / 2019 and 2019/ 2020) winter seasons. The Research Station region of the Sadat City University is characterized by a semi-arid climate with moderate cold winters and warm summers.

The soil of experimental field has a sandy texture. Some chemical and physical properties of soil tested were Page *et al.*,(1982)and the obtained data presented in Table (1).

Faba bean (*Vicia faba*) seeds of three cultivars (Nubaria3, Giza 843 and Giza 716) were sown in 10th November 2018 and 20th November 2019 seasons, respectively, under drip irrigation system. Plants thinned twice, the 1st after 15 days from sowing and the 2nd two weeks later. Calcium super phosphate (15.5% P₂O₅) and potassium sulphate (48.5 K₂O) in the rate of 200 and 50 kg/fed were broadcasting before sowing. Nitrogen fertilizer in the form of ammonium sulphate (20.5% N) in the rate of 15kg N/fed to enhancing saymputic bacteria and face the nutrients needs in the early stage of faba plants in this new cultivated area. The treatments were applied in split plot design with three replicates. The five studied treatments in this experiment were as follows:

T1= Control with pretreatment amendments.

T2= NPK at 100% the recommended doses of Mineral Fertilizers (RD)

T3= NPK at 75% (RD) + Rhizobia

T4= Compost (2.5 t/ fed.) +Rhizobia

T5= Compost (2.5 t/ fed.) + NPK at 75% (RD) + Rhizobia

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

CaCO ₃ (%)	Organic matter (%)	Particle size distr., (%)			Texture Class
		Sand	Silt	Clay	
1.9	0.3	88.6	4.8	6.6	Sandy

PH*	EC** dS. m-1	Soluble cations (meq/L)				Soluble anions (meq/L)			
		Ca ⁺⁺	Mg ⁺⁺	K ⁺	Na ⁺	CO ₃ ⁻⁻	HCO ₃ ⁻	Cl ⁻	SO ₄ ⁻⁻
7.63	1.82	0.36	0.32	0.14	0.56	-	0.41	0.36	0.61

- pH = 1:2.5 Soil: Water , **EC= 1:5 Soil: water

Assay of Enzyme Activities

Activities of the enzymes under study were determined according to the following methods:

- Dehydrogenase: colourimetrically, for the 2,3,5- triphenyl formazan (TPF) produced from the reduction of 2,3,5- triphenyl tetrazolium chloride (TTC), using acetone for extraction.....(Thalman.,1967).

- Microbial respiration in soil (CO₂) was estimated according to Jaggi (1975).
Analyses of variance were computed according to **Gomez and Gomez** (1984) using the least significant difference at 0.05 level to compare the differences among means.

Results and Discussion

The results demonstrate in Table (2) indicate that the plant height character in the three studied faba bean *Vicia faba* varieties during 2018- 2019 and 2019- 2020 seasons. Data showed significant variance among varieties which ranged between 94.6 and 99.6 cm in 2018-2019 season, while, in 2019- 2020 the plant height character ranged between 94.8 and 99.3cm. Variety Nubaria 3 recorded the highest values of plant height in the two seasons. On the other hand, Giza 843 variety recorded the lowest values at the two seasons. Data presented in Table (2) recorded also significant variance between or among all studied fertilization treatments on plant height character in the two seasons. Data showed that application of treatment contain (2.5 ton/fed compost + 75% recommended mineral + Bio) recorded the highest values 103.44and 102.44cm in the two seasons respectively and the lowest values 82.0 and 82.6 was observed with control in the two seasons respectively. Increasing in plant height character may be due to effect of compost which develops soil properly causing save water, macro and micro-elements and on aerobic media around root region adding to mineral fertilizer supplying plants. Effect of biofertilizer which solve absorption and adsorption problems all, the supporting action for interaction among the three items of application. These obtained results are in harmony which recorded by **El- Howeity M.A.(2008)**, **El-Shamy et al., 2015**, **Amini et al., 2016** and **Rasul 2017**.

Table (2) Effect of Bio- Organic Fertilizers on plant height of faba bean plants

Treatments		Plant height (cm)							
		2018/2019				2019/2020			
Varieties Fertilization		Nubaria 3	Giza 843	Giza 716	Mean	Nubaria 3	Giza 843	Giza 716	Mean
Control	T1	83.00	81.33	81.67	82.00	84.33	81.67	82.00	82.67
NPK at 100% (RD)	T2	99.67	98.00	100.33	99.33	98.00	96.00	99.00	97.67
NPK at	T3	97.67	92.67	95.00	95.11	95.00	93.00	94.00	94.00

75% (RD) + Rh.									
Compost 2.5 ton / fed + Rh	T4	92.67	92.00	91.33	92.00	90.00	90.00	95.00	91.67
Rh.+ Compost +75% NPK	T5	108.67	98.67	103.00	103.44	106.67	97.33	103.33	102.44
Mean		96.33	92.53	94.26	94.37	94.80	91.60	94.66	93.96
LSD at 5%:	Verities (V)	2.11				1.22			
	Fertilizers (F)	7.89				7.93			
	V x F	13.66				13.74			

Chlorophyll content:

Average of chlorophyll content in plant of three faba bean varieties as affected by fertilizer treatments as well as their interaction in 2018- 2019 and 2019- 2020 seasons is presented in Table (3). Results indicate that faba bean variation significantly differed in chlorophyll content in both seasons. In 2018- 2019, Giza 718 gave the highest value 49.80 of chlorophyll content, while, variety Nobareia 3 gave the lowest value 48.16. In 2019-2020, variety Giza 718 gave the highest value 48.13 on the other hand, the variety Nobareia 3 recorded the lowest value 45.53. Chlorophyll content, significantly differed as affected by fertilization treatments. The treatment contains (2.5 ton/fed compos + 75% Mineral + Bio) gave the highest values 59.06 and 54.98 in the two seasons respectively while, control gave the lowest values 41.58 and 41.50 in both seasons respectively. Also, chlorophyll content in plant significantly differed as affected by interaction effect among faba bean varieties and fertilization treatments. On the other hand, the highest values of chlorophyll content was obtained with using (2.5 ton/fed compost + Mineral + Bio) that gave 48.33 chlorophyll content in 2018- 2019 and 2019- 2020 respectively. These results are in agreement with these of **El- Howeity M.A.(2008)**, **Rakha et al., (2013)**, and **El-Sayed et al., (2015)**.

Table (3) Effect of Bio- Organic Fertilizers on Chlorophyll content of faba bean plants

Treatments		Chlorophyll content							
		2018/2019				2019/2020			
Varieties		Nubaria 3	Giza 843	Giza 716	Mean	Nubaria 3	Giza 843	Giza 716	Mean
Fertilization									
Control	T1	42.23	40.76	41.76	41.58	41.90	42.67	39.93	41.50
NPK at 100% (RD)	T2	47.64	50.35	52.29	50.09	45.83	46.38	51.17	47.79
NPK at 75% (RD) +	T3	47.08	49.47	51.39	49.31	43.17	44.23	46.75	44.72
Compost 2.5 ton / fed	T4	45.73	48.41	48.16	47.43	45.87	43.53	49.23	46.21
Rh.+ Compost +75% NPK	T5	46.77	48.78	49.20	48.25	46.30	47.62	51.08	48.33
Mean		45.89	47.554	48.56	45.89	44.61	44.89	47.63	45.71
LSD at 5%:	Verities (V)	0.78				1.31			
	Fertilizers (F)	4.66				3.89			
	V x F	8.07				6.74			

CO₂ content in Soil:

Average CO₂ content in soil of three faba bean varieties as affected by fertilization treatments and their interaction in 2018-2019 and 2019- 2020 seasons is presented in Table (4). Results show that CO₂ content in soil of faba bean varieties significantly differed in both seasons. Variety Nobareia 3 gave the highest values 30.28 and 30.28 of CO₂ in soil in 2018-2019 and 2019- 2020 seasons respectively. While variety Giza 716 and Giza 843 gave the lowest values of CO₂ in soil 27.96 and 27.96 in both 2018-2019 and 2019- 2020 seasons respectively. Also, data indicate that fertilization treatments significantly effects on CO₂ soil in both 2018-2019 and 2019- 2020 seasons. The highest values of CO₂ 39.89 obtained from application fertilizer (2.5 ton/fed compost + 75% Mineral + Bio) in both seasons respectively. While the lowest values 16.27 and 16.22 of CO₂ in soil was recorded with control in 2018-2019 and 2019- 2020 seasons, respectively. These results are harming with those obtained by **Baba et al., 2015** and **El-Ayarajaand Sathi Yammrthi 2020**.

Table (4) Effect of Bio-Organic fertilizers on CO₂ evaluation in the Rhizosphere soil

Treatments	Plant height (cm)	
	2018/2019	2019/2020

Varieties Fertilization		Nubaria 3	Giza 843	Giza 716	Mean	Nubaria 3	Giza 843	Giza 716	Mean
Control	T1	16.30	15.20	17.30	16.27	16.25	15.15	17.25	16.22
NPK at 100% (RD)	T2	25.27	24.03	23.20	24.17	33.55	23.98	23.15	26.90
NPK at 75% (RD) + Rh.	T3	32.10	31.08	33.15	32.11	22.72	31.03	33.10	28.95
Compost 2.5 ton / fed + Rh	T4	36.67	36.20	37.10	36.66	36.62	36.15	37.05	36.61
Rh.+ Compost +75% NPK	T5	41.10	39.00	39.57	39.89	41.05	38.95	39.52	39.84
Mean		30.288	29.102	30.064	29.82	30.038	29.052	30.288	29.10
LSD at 5%:	Ve ritie s (V)	0.78				1.31			
	Fe rtil ize rs (F)	4.66				3.89			
	V x F	8.07				6.74			

Dehydrogenase Enzyme :

Average of dehydrogenase enzyme of three faba bean varieties as affected by fertilization treatments and their interaction in 2018-2019 and 2019- 2020 seasons are presented in Table (5). Results indicate that dehydrogenase enzyme of faba bean varieties significantly differed in both 2018-2019 and 2019- 2020 seasons. Variety Nobareia 3 gave the highest values 28.64 and 29.07 μ gTPF /100 g dry soil/day dehydrogenase in the two seasons respectively. On other side, the lowest values of dehydrogenase recorded with variety Giza 716, 27.19 and 28.29 in 2018-2019 and 2019- 2020 seasons respectively. Also, data indicate that significant variances in dehydrogenase enzyme anemone all fertilization treatments in both 2018-2019 and 2019- 2020 seasons. The fertilization treatment (2.5 ton/fed compost + 75% Mineral + Bio) recorded the highest values 30.06 and 33.36 at 2018-2019 and 2019- 2020 seasons respectively. On the other hand, the lowest values of dehydrogenase 20.75 and 21.03 was obtained with control in both 2018-2019 and 2019- 2020 seasons respectively. Results show that the effect of interaction between faba bean varieties fertilization treatment on dehydrogenase enzyme was significant in

both 2018-2019 and 2019- 2020 seasons. These results are in the same line with those obtained by **Baba et al., 2015 and El-Ayarajaand Sathi Yammrthi 2020.**

Table (5) Effect of Bio-Organic fertilizers on Dehydrogenase activity in the rhizosphere soil of faba bean plants

Treatments		Dehydrogenase activity ($\mu\text{g TPF}/100 \text{ d.Soil}/24\text{h.}$)							
		2018/2019				2019/2020			
Varieties	Fertilization	Nubaria 3	Giza 843	Giza 716	Mean	Nubaria 3	Giza 843	Giza 716	Mean
control	T1	22.02	20.02	20.22	20.75	21.00	21.19	20.90	21.03
NPK at 100% (RD)	T2	25.60	25.73	25.30	25.54	28.00	28.25	27.10	27.79
NPK at 75% (RD) + Rh.	T3	30.40	29.87	29.10	29.79	31.25	30.27	30.13	30.55
Compost 2.5 ton / fed + Rh	T4	31.82	30.10	30.40	30.77	31.08	30.45	30.67	30.73
Rh.+ Compost +75% NPK	T5	33.35	31.27	30.97	31.86	34.04	34.26	32.68	33.66
Mean		28.64	27.39	27.19	27.74	29.07	28.88	28.29	28.75
LSD at 5%:	Verities (V)	0.78				1.31			
	Fertilizers	4.66				3.89			
	V x F	8.07				6.74			

Faba bean Seed yield

Average of seed yield per feddan of the three studied faba bean varieties as affected by fertilization treatments as well as their interaction effects in 2018-2019 and 2019- 2020 seasons, is presented in Table (6). Data show that faba bean varieties significantly differed in seed yield per feddan in both seasons. Nobaria 3 gave the highest values of seed yield per feddan 1297.67and 1266.40 kg per feddan in both seasons, respectively. On the other hand, variety Giza 716 recorded the lowest values 1240.27and 1232.00 kg per feddan in both seasons, respectively. These results are in harmony with those of Rakha *et al., 2013 and Fouda 2017.* Likewise, results presented in table(6) show the effect of fertilization treatments on seed yield per feddan was significant in both 2018- 2019 and 2019- 2020 seasons. Seed yield per feddan increased as application fertilizer contain (2.5 ton/fed compost + 75% Mineral + Bio) where this treatment recorded the highest value of seed yield per feddan 1347.11and 1326.56 kg per feddan in both 2018-2019 and 2019-

2020 seasons respectively. While plants received full doses from nitrogen fertilizer recorded the values 1326.56 and 1301.78 kg per feddan in 2018-2019 and 2019- 2020 seasons respectively. These obtained results are in agreement with those of **Baba et al., 2015**, **El-Sayed et al., (2015)** , **El-Shamy et al., (2016)** and **El-Ayaraja and Sathi Yammrthi (2020)**.

Table (6) Effect of Bio- Organic fertilizers on seed yield (Kg/fed.) of faba bean varieties

Treatments		Seed Yield (Kg/fed.)							
		2018/2019				2019/2020			
Varieties Fertilization		Nubaria 3	Giza 843	Giza 716	Mean	Nubaria 3	Giza 843	Giza 716	Mean
control	T1	1211.67	1178.33	1114.67	1168.22	1184.33	1161.67	1105.00	1150.33
NPK at 100% (RD)	T2	1351.67	1308.33	1298.33	1319.44	1308.00	1300.67	1296.67	1301.78
NPK at 75% (RD) + Rh.	T3	1280.00	1265.00	1235.00	1260.00	1238.33	1220.00	1218.33	1225.56
Compost 2.5 ton / fed + Rh	T4	1260.00	1380.00	1231.67	1290.56	1255.00	1368.33	1226.67	1283.33
Rh.+ Compost +75% NPK	T5	1385.00	1334.67	1321.67	1347.11	1346.33	1320.00	1313.33	1326.56
Mean		1297.67	1293.27	1240.27	1277.07	1266.40	1274.13	1232.00	1257.51
LSD at 5%:	Verities (V)	0.78				1.31			
	Fertilizers	4.66				3.89			
	V x F	8.07				6.74			

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