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EFFECT OF BIO- AND CHEMICAL FERTILIZERS ON VEGETATIVE GROWTH OF BROAD BEAN CULTIVARS

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ABSTRACT
A field experiment was carried out at 2018 -2017 growth season in Babylon / Saddat El-Hindia, Iraq in clay loam soil to study the effect of bio-fertilizer (addition and control) and chemical fertilizers (0 , 40 and 80 kg.ha^{-1} of NPK 19-19-19+te) on some vegetative traits of three broad bean cultivars (local, ricko, luzdi). Randomized complete block design with four replicates was used. The results indicates that Ricko cultivar was superior in plant height, plant leaf area, and chlorophyll leaf content (127.32 cm, 60.48 cm^2 and 52.88 SPAD) respectively. While Lozdi cultivar gave the highest average in plant leaves and branches (112.2 leaves and 8.58 branches) respectively. Bio-fertilizer was superior in plant height, plant leaf area, number of leaves, branches and root-nodes and chlorophyll leaf content (122.59 cm, 61.43 cm^2, 115.2 leaves, 51.6 root-nodes and 54.42 SPAD) respectively compared to control treatment. Chemical fertilizer was significantly superior at 40 kg.ha^{-1} by giving the highest plant height, number of leaves, branches and root-nodes (121.54 cm, 115.7 leaves, 8.15 branches and 48.6 nodes). The level of 80 kg.ha^{-1} gave the largest plant leaf area and chlorophyll content (63.71 cm^2 and 52.59 SPAD), compared to control treatment. The interactions showed a significant effect in vegetative growth traits.
KEY WORDS: *broad bean cultivars, bio-fertilizer, chemical fertilizer*

INTRODUCTION

Broad bean (*Vicia faba* L.)is an important crop because it is one of the most consumed crops due to its multiple uses. There are a large number of genotypes that differ in growth and outcome through their affected by environmental conditions, therefore, selecting the genotypes for the region is an important option (Abbas, 2012). Several experiments have been conducted in the world to compare the performance of genotypes in different regions. Bio-fertilizers are added to supply the plant with its nutritional needs, including transformation the nutrients to available form for absorption, the provision of growth-stimulating and growth promoters as well as the stabilization of atmospheric nitrogen through its symbiotic or non-symbiotic lifestyle. In addition to protecting the plant host from some pathogenic factors, thereby rationalizing the use of mineral fertilizers by about 25% and reducing the costs of agricultural operations (Al-Haddad, 2003). Chemical fertilizer has an important role in increasing the production of agricultural crops by 50%, provided that there is a balance when added (Anon, 2004). Far *et al* (2014) in Iran studied 3 varieties of broad bean (Algerian, Barakat and Shami) incorporated or not with Rhizobium, and fount that the highest number of root nodes resulted when mixing with Rhizobium compared to control treatment. Zaghloul *et al.* (2015) in Egypt, when adding NPK fertilizer and Rhizobium to pea, found that all growth indicators were

increased with the addition of bi-fertilizer. Jasim et al. (2016) in experiment with 200 kg.ha^{-1} chemical fertilizer (19-19-19+te NPK) and 10 t.ha^{-1} sheep manure in saline soil, found that both fertilizers caused significant increases in plant height, leaves and branches number and chlorophyll content compared to control .

MATERIALS AND METHODS

A field experiment was carried out during 2017-2018 growth season in Babylon/Saddat El-Hindia, Iraq in clay-loam soil (Table 1) to study the effect of bio-fertilizer (seed incorporated or not) and three levels of NPK (0, 40 and 80 kg.ha^{-1}) on vegetative traits of three broad bean cultivars (Local, Ricko and Luzdy). Randomized complete block design with four replicates was used. The experimental unit included three ridges, 75 cm apart and 25 cm between hills on both ridge sides. The seeds were soaked for 24 hours before planting and then incorporated with bio-fertilizer (in the case of treatment), and seeded at 20/10/2017. The bio-fertilizer included *Rhizobium, Azospirillum, Azotobacter, Pseudomonas, Bacillus* and *Trichoderma* incorporated with Arabic gum. At green pods maturity, root-nodes number were calculated as an average of ten plants whose roots were carefully extracted with the presence of water as a source of mud clearance. Plant height, plant leaves and branches number were calculated as the mean of 10 plants taken randomly from each experimental unit. Leaf chlorophyll content was estimated by the Chlorophyll meter (SPAD).

TABLE 1. Some characteristics of field soil before planting

character	value		character	value
Organic matter g.kg^{-1}	1.55		Available N mg.kg^{-1}	50.3
Sand (g.kg^{-1})	240		Available P mg.kg^{-1}	10.4
Silt (g.kg^{-1})	425		Available K mg.kg^{-1}	210
Clay (g.kg^{-1})	335		Available Ca mg.kg^{-1}	1200
Soil texture	clay loam		Ec dS.m^{-1}	1.2
Organic matter (g.kg^{-1})	1.55		pH	7.8

RESULTS AND DISCUSSIONS

PLANT ROOT-NODES NUMBER. Table 2 showed that cultivars did not differ in root-nodes number, while incorporated seeds with bio-fertilizer caused significant increase in plant root-nods (51.6) compared to control treatment (41.8), with an increase percentage of 23.4%. Number and size of root-nodes are affected by Rhizobium type and characters (Sceublin & Van der Heijen, 2006). The presence of fertilized organisms leads to increase production of growth regulators and thus promotes growth and the formation of more root nodes that contribute to nitrogen stabilization and to improved root growth and proliferation (Akhtar & Siddiqui, 2009). Chemical fertilizer also increased the number of root nodes and fertilizer level of 80 and 40 kg.ha^{-1} gave the highest number of root nodes, while control treatment gave the least number. This result is to that chemical fertilizer led to increase root growth and proliferation as well as the activity of fertilized organisms and therefore increase root-nodes (Turk & Tawaha, 2002). The interaction between the cultivars and bio-fertilizer had a significant effect. Local and Ricko varieties with bio-fertilizer were distinguished, while Lozdi cultivar with control treatment gave the lowest number of root-nodes. This result was consistent with Yadegari (2009) and Far *et al*. (2014). The interaction between bio- and chemical fertilizer caused significant effect and reached a maximum of 55.8 when adding 40 kg.ha^{-1} chemical

fertilizer with bio fertilizer, while control gave the lowest number of root-nodes (39.4). Local cultivar with bio-fertilizer and 40 kg.ha^{-1} chemical fertilizer gave the highest number of root-nodes (60.5), while the lowest root-nodes (37.5%) obtained from luzdi cultivar without bio- and chemical fertilizers, with a percentage increase of 61.3%.

TABLE 2. Effect of cultivar, bio- and chemical fertilizers on plant root-nodes number

cultivar	Bio-fertilizer	Chemical fertilizer (kg.ha^{-1})			Cultivar*bio-fertilizer
		0	40	80	
Local	control	39.5	46.2	47.0	44.2
	with	47.5	60.5	52.0	53.3
Luzdi	control	37.5	38.0	44.8	40.1
	with	47.5	49.2	47.2	48.0
Ricko	control	41.2	40.0	42.0	41.1
	with	47.8	57.7	54.7	53.4
Average of chemical fert.		43.5	48.6	48.0	
LSD $_{0.05}$		Chemical=6.36	interaction=15.57		8.99
The interaction of cultivar * chemical fertilizer					average of var.
Local		43.5	53.4	49.5	48.8
Luzdi		42.5	43.6	46.0	44.0
Ricko		44.5	48.9	48.4	47.2
LSD $_{0.05}$		11.01			n.s
The interaction of bio- * chemical fertilizer					average of bio-
39.4		41.4	44.6	41.8	39.4
47.6		55.8	51.3	51.6	47.6
LSD $_{0.05}$		8.99			5.19

PLANT HEIGHT (cm). Table (3) shows that the cultivars differed significantly in plant height and Ricko cultivar was superior (127.39 cm), while Luzdi cultivar gave the lowest height (117.32 cm) with a percentage increase of 8.58%. This may be due to genetics differences and cultivar responses to environment (Ianovici *et al,* 2017). This result was consistent with Abdelmula & Abuanja (2007). Bio-fertilizer caused significant effect on plant height to 122.59 cm compared to control treatment (112.84 cm) with an increase percentage of (8.64%). This may be due to the effect of fertilized organisms in increasing root-nodes number significantly compared to control (Table 2), and the organisms produce of nitrogen and growth regulators (Sharma *et al.,* 2003; Moawad *et al.,* 2004). This result was consistent with Nishita & Joshi (2010) and Badr *et al* (2014). Chemical fertilizer caused significant increase in plant height compared to control. This result was due to that legume plants need more phosphorus than other plants to ensure better growth (Gitari & Mureith, 2003). This result was consistent with Qasim *et al.* (2009). The interaction between cultivars and bio-fertilizer caused significant effect, and Ricko cultivar with bio-fertilizer was superior (131.22 cm), while Luzdi cultivar with control gave the lowest height (102.88 cm) with an increase percentage of 27.54%. This result was due to the differences of root-nodes number, and cultivar efficiency of photosynthesis (Shalaby *et al*, 2000, Ahmed & Badr, 2009). It may be due to the fact that nitrogen-fixing bacteria (*Azotobacter* and *Azospirillium*) produce sufficient amounts of IAA and cytokinin that lead to increase plant length (Noel *et al.,* 1996), and this is in line with Ahmed *et al.* (2012). The interaction between bio- and chemical fertilizer had a significant effect and reached the highest intensity when adding 40 kg.ha^{-1} chemical fertilizer with bio-

fertilizer, while the control treatment gave the lowest plant height. Ricko cultivar with bio-fertilizer and 40 kg.ha-1 chemical fertilizer was significantly superior (134.5 cm), while Luzdi without fertilizer gave the lowest height (97.9 cm).

TABLE 3 Effect of cultivar, bio- and chemical fertilizers on plant height(cm)

cultivar	Bio-fertilizer	Chemical fertilizer (kg.ha^{-1})			Cultivar*bio-fertilizer
		0	40	80	
Local	control	103.95	114.63	117.70	112.09
	with	118.93	123.25	125.45	122.54
Luzdi	control	97.90	106.73	104.00	102.88
	with	110.58	123.10	108.40	114.03
Ricko	control	113.78	127.03	129.90	123.57
	with	126.53	134.50	132.62	131.22
chemical fert. average		111.94	121.54	119.68	
LSD $_{0.05}$		Chemical=4.84 interaction=11.86			6.85
The interaction of cultivar * chemical fertilizer					Var. average
Local		111.44	118.94	121.58	117.32
Luzdi		104.24	114.91	106.20	108.45
Ricko		120.15	130.76	131.26	127.39
LSD $_{0.05}$		8.39			4.84
The interaction of bio- * chemical fertilizer					Bio- average
control		105.21	116.13	117.20	112.84
with		118.68	126.95	122.16	122.59
LSD $_{0.05}$		6.85			3.95

PLANT LEAF AREA (cm^2). Table (4) shows that cultivars had a significant effect on plant leaf area (PLA), and Rico cultivar exceeded the other two cultivars and reached 60.48 cm^2. The differences were due to differences in genotype composition and its response to the environment as a result of the interaction between genetics and the environment (Abdelmula & Abuanja 2007; Ianovici *et al.,* 2015; Datcu *et al,* 2017).

The bio-fertilizer caused significant effect as it increased PLA to 61.43 cm^2 compared to control treatment (55.62 cm^2) with a percentage increase of (10.445%). This may be due to the fact that the addition of fertilized organisms led to processing of nitrogen and plant growth regulators (Zendejas *et al.,* 2015). This is consistent with Mohamed & Gomaa (2005) and El-Wakeil (2007) Who showed that the characteristics of vegetative growth increased when treated with bio-fertilizer compared to control treatment, and that mixing of fertilized microorganisms caused more effect (Moawad *et al.,* 2004), or due to the fact that bio-fertilizer increased root growth and the number of root-nodes (Table 2), which caused an increase absorption surface area and nitrogen fixation as well as its availability (Zendejas *et al.,* 2015). Chemical fertilizer increased PLA and the level of 80 kg.ha^{-1} gave the highest PLA to 63.71 cm^2, while control treatment gave 51.20 cm^2 with a percentage increase of 24.43%. This result was due to phosphorus that lead to increase PLA by increases cell division and expansion (Asuero *et al.,* 2004; Kavanova *et al.,* 2006). The presence of phosphorus is important because it enters into the formation of amino acids, fatty acids and phosphoric energy compounds, and thus increased the accumulation and expansion of dry matter (El Habbasha *et al.,* 2007). This result was consistent with Mokhtar (2001). The interaction between cultivars and bio-fertilizer caused significant effect and the Rico cultivar with bio-fertilizer was distinguished and gave 62.49 cm^2,

while local cultivar with control treatment gave the lowest PLA (53.73 cm^2) with an increase percentage of 16.303%. The encouraging effect of bio-fertilizers by providing available nutrients for absorption leads to increase vegetative growth and PLA (Aduloju *et al.,* 2009).

TABLE 4. Effect of cultivar, bio- and chemical fertilizers on plant leaf area(cm^2)

cultivar	Bio-fertilizer	Chemical fertilizer ($kg.ha^{-1}$)			Cultivar*bio-fertilizer
		0	40	80	
Local	control	45.53	57.28	58.38	53.73
	with	53.88	63.30	65.20	60.79
Luzdi	control	48.08	54.00	61.93	54.67
	with	53.28	63.05	66.73	61.02
Ricko	control	50.28	63.18	61.98	58.48
	with	56.20	63.20	68.08	62.49
Average of chemical fert.		51.20	60.67	63.71	
$LSD_{0.05}$		Chemical=2.25	interaction=5.51		3.18
The interaction of cultivar * chemical fertilizer					average of var.
Local		49.70	60.29	61.79	57.26
Luzdi		50.68	58.53	64.33	57.84
Ricko		53.24	63.19	65.03	60.48
$LSD_{0.05}$		3.89			2.25
The interaction of bio- * chemical fertilizer					average of bio-
control		47.96	58.15	60.76	55.62
with		54.45	63.18	66.67	61.43
$LSD_{0.05}$		3.18			1.84

The interaction between cultivars and chemical fertilizer had a significant effect and Ricko cultivar with 80 $kg.ha^{-1}$ was superior by giving the highest PLA (65.03 cm2), while Local cultivar with control treatment gave the lowest PLA (49.70 cm^2), with a percentage increasing of 30.9%. The interaction between bio- and chemical fertilizers caused significant effect and bio- fertilizer with 80 $kg.ha^{-1}$ gave high PLA (66.67 cm^2), while control treatment gave the least PLA (49.96 cm^2). This is due to the availability of available nutrients for absorption with the presence of rhizobium, which leads to increase production of auxin and gibberellins and then increase cell division and expansion (Afzal *et al.,* 2010). Ricko cultivar with bio- and 80 $kg.ha^{-1}$ chemical fertilizers gave highest PLA (68.08 cm^2), while local cultivar without fertilizers gave the lowest PLA (45.53 cm^2).

PLANT LEAVES NUMBER. Table (5) shows that the varieties did not differ significantly in plant leaves number, while bio-fertilizer caused significant effect by increasing it to 115.2 compared to control treatment (103.4), with an increase of 11.4%. This is in line with Mohamed & Gomaa (2005), El-Wakeil (2007) and Zendejas *et al.* (2015) who found that the addition of fertilized organisms led to increase leaves number in the plant. Adding chemical fertilizer increased plant leaves number, and the level of 40 $kg.ha^{-1}$ fertilizer gave the highest number (115.7), while control treatment gave the lowest number (97.3). The interaction between cultivars and chemical fertilizer caused significant effect. Local and Luzdi cultivars with 40 or 80 kg.ha-1 chemical fertilizer were superior. The interaction between bio- and chemical fertilizers caused significant effect and reached a maximum of (126.3) when adding the chemical fertilizer at 40 $kg.ha^{-1}$ with bio- fertilizer, while control treatment gave the lowest

number of leaves (95.3). Local cultivar with bio- and 40 or 80 kg.ha^{-1} chemical fertilizers gave the highest leaves number .

NUMBER OF BRANCHES PER PLANT. Table (6) shows that cultivars caused significant effect on the number of branches / plant, and Lozdi cultivar was superior by giving (8.66), while Local cultivar gave the lowest number (7.55). This result was due to genotypes differences, their susceptibility to the surrounding conditions, the difference in the efficiency of photosynthesis and their content of internal hormones (Shalaby *et al,* 2000). This result was agreed with Ahmed & Badr (2009). Bio-fertilizer had no significant effect on the number of plant branches. Adding chemical fertilizer increased significantly plant branch number compared to control treatment with out differences between 40 and 80 kg.ha^{-1}. This was due to the provision of nutrients that contributed to improvement of growth and increase the number of branches of the plant (Elkhatib, 2009), and the increase of phosphate fertilizer promote root development , thus leads to increase vegetative growth and the number of plant branches. This result was consistent with Ismail (2002), and Gabr *et al* (2007). The interaction between cultivars and bio-fertilizer caused significant effect and Luzdi cultivar with bio-fertilizer gave the highest branches number (9.09), while Local cultivar without bio-fertilizer gave the lowest number of branches (7.41) with an increase percentage of (22.7%). The interaction between cultivars and chemical fertilizer caused significant effect and Luzdi cultivar with 40 kg.ha-1 gave the highest number (9.21). The presence of fertilized organisms encouraged the uptake of the elements due to increased availability, then photosynthesis, which led to an increase branches (Badr et al., 2013). The interaction between Luzdi cultivar, bio- and 40 kg.ha^{-1} chemical fertilizers gave highest number of plant branches (10.20), while Local cultivar without fertilizers gave the lowest number (6.75) with a percentage increase of 51 %.

TABLE 5. Effect of cultivar, bio- and chemical fertilizers on plant leaves number

cultivar	Bio-fertilizer	Chemical fertilizer (kg.ha^{-1})			Cultivar*bio-fertilizer
		0	40	80	
Local	control	87.3	97.2	102.3	101.8
	with	105.9	142.9	128.0	119.4
Luzdi	control	88.9	114.7	116.0	106.5
	with	103.2	124.7	125.8	117.9
Ricko	control	91.3	103.1	111.1	101.8
	with	107.4	111.4	106.2	108.3
chemical fert. average		97.3	115.7	114.9	
LSD $_{0.05}$		Chemical=12.6 interaction=31.0			17.87
The interaction of cultivar * chemical fertilizer					var. average
Local		96.6	120.0	115.1	110.6
Luzdi		96.0	119.7	120.9	112.2
Ricko		99.4	107.3	108.7	105.1
LSD $_{0.05}$		21.89			n.s
The interaction of bio- * chemical fertilizer					bio-fert. average
control		95.3	105.0	109.8	103.4
with		99.3	126.3	120.0	115.2
LSD $_{0.05}$		17.87			10.32

TABLE 6. Effect of cultivar, bio- and chemical fertilizers on plant branches number

cultivar	Bio-fertilizer	Chemical fertilizer (kg.ha^{-1})			Cultivar*bio-fertilizer
		0	40	80	
Local	control	6.75	7.35	8.12	7.41
	with	7.75	7.12	8.20	7.69
Luzdi	control	7.92	8.22	8.55	8.23
	with	8.17	10.20	8.90	9.09
Ricko	control	7.35	7.60	9.55	8.17
	with	7.05	7.55	8.20	7.60
chemical fert. average		7.50	8.01	8.59	
LSD $_{0.05}$		Chemical=0.87 interaction=2.12			1.22
The interaction of cultivar * chemical fertilizer					var. average
Local		7.25	7.24	8.16	7.55
Luzdi		8.05	9.21	8.72	8.66
Ricko		7.20	7.57	8.88	7.88
LSD $_{0.05}$		1.499			0.865
The interaction of bio- * chemical fertilizer					bio-fert. average
control		7.34	7.72	8.74	7.94
with		7.66	8.29	8.43	8.13
LSD $_{0.05}$		1.224			0.706

LEAF CHLOROPHYLL CONTENT (SPAD). Table (7) shows that cultivars caused significant effect on the leaf chlorophyll content and Ricku cultivar was superior compared to the other cultivars by giving 52.88 SPAD, while Luzdi cultivar gave the lowest value (44.80). This results was agreed with Abdelmula & Abuanja, (2007). Bio-fertilizer caused significant effect as it increased leaf chlorophyll content to (54.42) compared to control (42.71). The effect of fertilized organisms in increasing chlorophyll was due to increased nitrogen uptake by nitrification (Chandrasekhar *et al.,* 2005) that promotes growth by increasing processed materials and encouraging absorption and thereby increasing the chlorophyll content (Hassan, 2009). This result was agreed with Badr *et al*. (2013). Chemical fertilizer increased chlorophyll leaf content and the level of 80 kg.ha^{-1} gave the highest chlorophyll content (52.59) while control treatment gave the lowest value (43.42) with an increase percentage of 21.1%. Adding nitrogen fertilizer at vegetative growth stage promote chlorophyll content because of its enters into chlorophyll (Sing *et al,* 2016). The encouraging effect of phosphorus may be due to its role in increasing physiological processes, including photosynthesis, starch and protein formation, because it inters in nucleic acids, phosphorus lipids, enzymatic and energy compounds (El Habbasha *et al.,* 2007). The interaction between cultivars and bio-fertilizer had a significant effect, and Rico cultivar with bio- fertilizer gave (58.93), while Lusdi cultivar without bio fertilizer gave least chlorophyll content (38.85). The interaction between cultivars and chemical fertilizer caused significant effect and Rico cultivar with 80 kg.ha^{-1} gave the highest value (57.26), while Luzdi cultivar with control treatment gave the lowest value (41.19). The interaction between the addition of bio- and chemical fertilizer was significant and reached the highest intensity when adding the chemical fertilizers at the level of 80 kg E-1 with the addition of the bio fertilizer (59.01) while the treatment of the addition of any of the fertilizers of the lowest content of chlorophyll / leaves amounted to (39.02). Richo cultivar with bio- and 80 gk.ha^{-1} gave highest chlorophyll content (64.05), while Luzdi cultivar without fertilizers gave the lowest value (36.52).

TABLE 7. Effect of cultivar, bio- and chemical fertilizers on chlorophyll leaf content (SPAD)

cultivar	Bio-fertilizer	Chemical fertilizer ($kg.ha^{-1}$)			Cultivar*bio-fertilizer
		0	40	80	
Local	control	37.45	43.82	46.05	42.44
	with	48.35	53.45	58.95	53.58
Luzdi	control	36.52	38.05	41.97	38.85
	with	45.85	52.37	54.02	50.75
Ricko	control	43.10	46.90	50.47	46.82
	with	49.22	63.52	64.05	58.93
chemical fert. average		43.42	49.69	52.59	
$LSD_{0.05}$		Chemical=2.19 interaction=5.37			3.10
The interaction of cultivar * chemical fertilizer					var. average
Local		42.90	48.64	52.50	48.01
Luzdi		41.19	45.21	48.00	44.80
Ricko		46.16	55.21	57.26	52.88
$LSD_{0.05}$		3.796			2.192
The interaction of bio- * chemical fertilizer					bio-fert. average
control		39.02	42.92	46.17	42.71
with		47.81	56.45	59.01	54.42
$LSD_{0.05}$		3.099			1.789

CONCLUSIONS

It could be concluded that Riko cultivar was significantly superior compared to Luzdi and Local cultivars in plant height, plant leaf area and chlorophyll content. Bio-fertilizer led to increase root-nodes number, plant height, leaves number, plant leaf area and chlorophyll content. Chemical fertilizer improved plant growth without significant differences between 40 and 80 kg.ha-1. Bio-fertilizer was compensate of chemical fertilizer in most qualities except plant leaves number and area, and chlorophyll content.

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