Plant Archives Vol. 19, Supplement 1, 2019 pp. 246-251 **e-ISSN:2581-6063 (online), ISSN:0972-5210**

RESPONSE OF SOME BROAD BEAN (*VICIA FABA* L.) VARIETIES TO BIO AND CHEMICAL FERTILIZATION ON SEED YIELD

Dalia Salman Khudair and Ali Hussein Jasim
Agriculture College, Al-Qasim Green University, Iraq
Corresponding author: ajasim11@gmail.com

Abstract

A field experiment was carried out during the growing season of 2017 -2018 in Babilon, Al-Hindia in loam clay soil to study the performance of three faba bean varieties (local, Ricko and Luzdi) to bio-fertilizer (seed corporation and control) and chemical fertilizer (NPK, 19-19-19 + ME) in three levels (0, 40 and 80 kg.ha^{-1}). Randomized complete block design with 4 replications was used. The seeds were planted at 20/10/2017 on ridges (75 cm apart) planted on both sides and 25 cm between hills. The results were summarized as follows: Luzdi variety was superior in seed yield traits and gave the highest yield of dry pod yield, weight of 100 seeds and the biological yield, which reached (7.583 g, 127.21 g and 11.448 t.ha^{-1}), respectively. While Ricko variety was superior in seeds number per pod and seed yield (6, 3 seeds per pod and 3,491 t.ha^{-1}), respectively. Bio-fertilizer treatment was superior significantly by giving the highest averages of seeds number per pod and biological yield (6.3 seeds / pod and 11.190 t.ha^{-1}), respectively compared to control treatment. Chemical fertilizer at the level of 80 kg.ha^{-1} was superior significantly by giving highest number of seeds per pod, weight of 100 seeds, total seed yield and biological yield, which reached 6.4 seeds per pod, 128.73 g, 3.829 t.ha^{-1} and 11.646 t.ha^{-1}), respectively compared to control treatment. Local variety* bio-fertilizer* chemical fertilizer at 80 kg.ha^{-1}gave the highest weight of 100 seeds and seed yield (138.1 g and 4.217 t.ha^{-1}), respectively. While Luzdi variety* bio-fertilizer* chemical fertilizer at 80 kg.ha^{-1} gave the highest biological yield (13.136 t.ha^{-1}).

Keywords: Faba bean varieties, bio-fertilizer, chemical fertilizer.

Introduction

Faba bean (*Vicia faba* L.) is one of legume winter crops, whose seeds contain a high protein content estimated to 25-40% (Gutierrez *et al*., 2008). This increases the importance of this crop due to its high nutritional value and as a cheap source of protein compared to animal protein (Alghamdi, 2009). The addition of bio-fertilizer may provide the plant with ideal conditions for growth by increasing nutrient availability in the soil as a result of increasing microorganisms activity in analysis of organic matter and reduction of soil pH (Huang *et al*., 2017), which reduces chemical fertilizers requirement. The major elements of NPK are important in plant nutrition, which is constantly needed during its growth. The requirements for these elements are increased during vegetative growth, flowering and fruiting. The plant absorbs nutrients at a rate equal to its growth rate (Al-Shahhat, 2007), thus, increasing the pollination rate and reducing flower dropping will certainly increase seed yield. Therefore, the research was carried out to determine the effect of bio- and chemical fertilizer on crop yield and its components for some faba bean varieties. Abbas (2012) found that Foly variety when fertilized with 160 kg.ha^{-1} gave the highest averages in pod length, pods number per plant, weight of 100 seeds and seeds yield. Badr *et al*. (2013) in Egypt when adding bio-fertilizer (VA-mycorrhizal) on two faba bean varieties (Sakha and Giza 461), found that Sakha variety was superior in pods number, seeds number and seed yield. Shafeek *et al*. (2016) in Egypt found that seed mixing with bio-fertilizer and nitrogen-fixing bacteria at 1 and 2 kg. Fadan^{-1}, improved pods and yield.

Materials and Methods

A field experiment was carried out during the winter season 2017-2018 in Babylon/Al-hindia in a clay-loam soil (Table 1), as factorial experiment according to randomized complete block design with four replication. It included three faba bean varieties (Local, Ricko, and Luzdi) in the main plots, three fertilizer (NPK, 19-19-19 +ME) levels (0, 40 and 80 kg.ha^{-1}) and two bio-fertilizer levels (control and added). The seeds were soaked for 24 hours and then mixed with bio-fertilizer (according to treatments) and planted in hills 25 cm on ridges 75 cm (on both sides of the ridge on 20/10/2017. At seed maturity, average number of seeds per pod, the weight of 100 dry seeds dry seed yield, biological yield were calculated.

Results and Discussion

Table (2) showed that cultivars, bio- and chemical fertilizers and all interactions had a significant effect on the number of seeds per pod. The varieties were differed in the number of seeds. pod^{-1} and Ricko variety was superior by giving 6.3 seeds, while Luzdi variety gave

the lowest number (5.99). This difference was due to the genetic differences and its response to the environment as a result of the interaction between genetics and the environment. This result was agreed with Abdelmula and Abuanja (2007).

Bio-fertilizer caused a significant effect by increasing the number of seeds. pod^{-1} to 6.3 compared with control treatment (6.06). This increase may be due to the fact that bio-fertilizer contributed to the stabilization of nitrogen and also to the producing of hormones like substances (Rizkand Shafeek, 2000and Badr *et al*., 2014), which helped in the process of seed growth and reduce competition and then gave high production (Rasool and Singh, 2016). This result was consistent with Ara *et al*. (2009). Adding chemical fertilizer caused an increase in seeds number. pod^{-1}, and the level of 80 $kg.ha^{-1}$ was the best significantly by giving (6.4) compared to control treatment (6.0). This increase was due to the fact that potassium caused an increases the enzymes, improving protein and carbohydrates construction and the transfer from source to sink (Taiz and Zeiger, 2006) as well as the role of nitrogen and phosphorus as important elements in plant nutrition. This is consistent with El-Shouny (2001).

Local variety with bio-fertilizer was the best by giving 6.6 seeds per pod, while Luzdi variety without bio-fertilizer gave the lowest (5.9). This was due to the differences between varieties and the effect of bio-fertilizer in increasing seeds per pod (Ara *et al.*, 2009). Local variety at the addition of 80 $kg.ha^{-1}$ chemical fertilizer was significantly superior by giving 6.6 seeds per pod compared to Luzdi and Ricko varieties with control (without chemical fertilizer). This may be due to the role of chemical fertilizer in improving the growth and nutritional status of the plant as well as the role of phosphorus in increasing root spread and development, which was reflected in increasing pod seed number. Local variety with bio-fertilizer and chemical fertilizer (80 $kg.ha^{-1}$) gave highest pod seeds number (6.95), while the same variety with control (without fertilizer) gave the lowest pod seeds number (5.75).

Table (3) showed that cultivars caused a significant effect on the weight of 100 dry seeds and Luzdi variety gave the highest weight of 100 seeds (127.21 g), while Ricko variety gave the lowest weight of 100 seeds (119.05 g). This was due to the differences of varieties genotypes and their susceptibility to the surrounding conditions. This was consistent with Badr *et al*. (2013). Bio-fertilizer caused a significant effect by increasing the weight of 100 dry seeds to 128.83 g compared to control (119.59 g). This increase may be due to the fact that bio-fertilizer increase nitrogen availability and hormones like substances, which delay plant aging and thus increase the period of seeds filling, which led to increase weight. This was consistent with Ara *et al*. (2009).Chemical fertilizer also increased the weight of 100 dry seeds and the level of 80 $kg.ha^{-1}$ gave higher weight (128.73 g), while control treatment gave the lowest weight of 100 dry seeds (119.90 g). This is due to the fact that legume plants need more phosphorus than other plants to ensure better growth and productivity (Gitari and Mureith, 2003), as well as the role of potassium in increasing the efficiency of enzymes and improving protein and carbohydrates synthesis and the process of transferring from source to sink (Taiz and Zeiger, 2006). This result was consistent with Qasim *et al*. (2009).

Luzdi and local varieties with bio-fertilizer gave the highest weight of 100 dry seeds (131.47 and 132.15 g) while Ricko variety without bio-fertilizer gave the lowest weight of 100 dry seeds (115.23 g). Luzdi and local varieties with chemical fertilizer (80 $kg.ha^{-1}$) gave the highest weight, while Rico with control treatment gave the lowest weight of 100 dry seeds. This may be due to the genetically differences of these varieties and to the availability of potassium, which improved the transfer to seeds. The availability of phosphate fertilizer improved root mass development, which reflected in promoting vegetative growth and increases seed filling period. Local variety with bio-and chemical fertilizer gave highest weight (138.10 g), while Rico variety without fertilizers gave the lowest weight of (111.16 g).

Table (4) showed that cultivars caused a significant effect on the dry pod weight. Local and Luzdi varieties gave higher dry pod weight, while Ricko gave the lowest dry pod weight. This was due to the differences in genetic factors and its response to environmental factors. This is in line with Abdelmula and Abuanja and (2007). Bio-fertilizer caused a significant effect in increasing dry pod weight to (7.7 g) compared to control (6.99 g). This is due to the role of fertilizers in promoting growth and increasing nitrogen availability (Elkhatib, 2009). This is consistent with Ismail (2002), Solieman *et al*. (2003) and Gabr *et al*. (2007).

Chemical fertilizer also increased dry pod weight and the level of 80 $kg.ha^{-1}$ gave higher weight of 7.7 g, while control treatment gave the lowest dry pod weight (6.9 g). This may be due to the fact that potassium caused an increase in the efficiency of enzymes and improved protein and carbohydrates synthesis and the process of transport (Taiz and Zeiger, 2006) as well as nitrogen availability and the role of phosphorus in improving root growth and development (Erum, Bano, 2008 and Rasool and Singh, 2016). Luzdi variety with bio fertilizer gave the highest dry pod weight (7.9 g), while Ricko variety without bio fertilizer gave the lowest weight (6.7 g). This is due to the fact that mixing with nitrogen-fixing bacteria led to an increase root nods

number and then dry matter (Yadegari, 2009). Local variety with chemical fertilizer (80 kg.ha^{-1}) gave the highest weight (7.95 g). Local variety with bio- and chemical fertilizer (80 kg.ha^{-1}) gave the highest pod dry weight, while Ricko without fertilizers gave the lowest dry pod weight.

Table 5 : Showed that the varieties differed significantly in biological yield and Lozdi variety was superior by giving (11.448 t.ha^{-1}), while Ricko variety gave the lowest biological yield (10.082 t.ha^{-1}). This result was consistent with Abdelmula and Abuanja (2007). Bio-fertilizer caused a significant effect on biological yield by giving 11.190 t.ha^{-1} compared to control treatment (10.318 t.ha^{-1}). This increase may be due to the role of bio-fertilizer in improving plant growth (unpublished data) and the number and weight of seeds (Table 2 and 3). This result was consistent with Singh and Prasad (2008). Adding chemical fertilizer increased biological yield and the level of 80 kg.ha^{-1}gave highest value (11.646), while control treatment gave the lowest value (9.569 t.ha^{-1}). This result was consistent with Alipour *et al*. (2014). Luzdi variety with bio-fertilizer gave highest biological yield (11.906 t.ha^{-1}), while Ricko without bio-fertilizer gave (9.749), with an increase percentage of (22.1%). The interaction of varieties and chemical fertilizer caused a significant effect and Luzdi with chemical fertilizer (80 kg.ha^{-1}) gave the highest value (12.615), while Rico with control treatment gave the lowest value of 9.181 t.ha^{-1}), with an increase percentage of (37.4%). This is consistent with Alipour *et al*. (2014). The addition of both fertilizers gave higher biological yield (12.129), while control (without fertilizers) gave the lowest value (9.182). Luzdi variety with bio- and chemical (80 kg.ha^{-1}) fertilizers gave the highest value (13.136 t.ha^{-1}), while Rico variety without fertilizers gave the lowest value (8.915 t.ha^{-1}).

Table (6) showed that cultivars had no significant effect on dry seed yield. Adding bio fertilizer increased seed yield to 3.613 t.ha^{-1}, with an increase percentage of 10.3% compare to control. This increase was due to increasing seed number per pod (table 2) and the weight of 100 seeds (Table 3) which reflect in increasing seed yield. This result was in line with Shafeek *et al*. (2004), Nishita and Joshi (2010). Chemical fertilizer caused an increase in seed yield and the level of 80 kg.ha^{-1} gave the highest yield of 3.829 t.ha^{-1}, while control treatment gave the lowest rate (2.990 t.ha^{-1}) with an increase percentage of 28%. This result was agreed with Khandelwal (2012). Luzdi cultivars with bio- fertilizer significantly gave the highest seed yield (3.70 t.ha^{-1}), while Local variety without bio fertilizer gave lowest seed yield (3.183 t.ha^{-1}), with a percentage increase of (16.2%). This is due to increasing seed number per pod and the weight of 100 seeds, which led to differences in seed yield. This result was agreed with El-Shouny (2001). Local variety with chemical fertilizer at 80 kg.ha^{-1} gave highest seed yield of (3.895 t.ha^{-1}), while the same variety with control treatment gave the lowest seed yield of (2.793 t.ha^{-1}). Adding both fertilizers gave the highest yield of (4.097 t.ha^{-1}), while control treatment (without any fertilizer) gave the lowest seed yield (2.865 t.ha^{-1}), with an increase percentage of 43%. Local variety with bio- and chemical (80 kg.ha^{-1}) gave the highest seed yield of 4.217 t.ha^{-1}, while the same variety without fertilizers gave the lowest seed yield (2.609 t.ha^{-1}), with a percentage increase of (61.2%).

Table 1 : Some characteristics of field soil before planting

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

Table 2 : Effect of variety, bio- and chemical fertilizers on seeds number per pod

variety	Bio-fertilizer	Chemical fertilizer (kg.ha^{-1})			Variety* bio-fertilizer
		0	40	80	
Local	control	5.750	5.875	6.250	5.958
	with	6.475	6.275	6.900	6.550
Luzdi	control	5.900	5.575	6.125	5.867
	with	5.950	6.175	6.200	6.108
Ricko	control	6.125	6.500	6.400	6.342
	with	6.000	6.400	6.550	6.317
Average of chemical fert.		6.033	6.133	6.404	
LSD $_{0.05}$		Chemical =0.2683 interaction=0.6571			0.3794
The interaction of variety * chemical fertilizer					average of var.
Local		6.113	6.075	6.575	6.254
Luzdi		5.925	5.875	6.163	5.988
Ricko		6.063	6.450	6.475	6.329
LSD $_{0.05}$		0.4647			0.2683
The interaction of bio- * chemical fertilizer					average of bio-
control		5.925	5.983	6.258	6.056
with		6.142	6.283	6.550	6.325
LSD $_{0.05}$		0.3794			0.2190

Table 3 : Effect of variety, bio- and chemical fertilizers on weight of 100 dry seeds.

variety	Bio-fertilizer	Chemical fertilizer (kg.ha^{-1})			Variety* bio-fertilizer
		0	40	80	
Local	control	116.53	120.46	124.77	120.59
	with	126.33	132.03	138.10	132.15
Luzdi	control	117.19	122.39	129.28	122.95
	with	127.87	132.11	134.44	131.47
Ricko	control	111.16	113.45	121.07	115.23
	with	120.31	123.57	124.70	122.86
Average of chemical fert.		119.90	124.00	128.73	
LSD $_{0.05}$		Chemical =2.508 interaction= 6.144			3.547
The interaction of variety * chemical fertilizer					average of var.
Local		121.43	126.25	131.43	126.37
Luzdi		122.53	127.25	131.86	127.21
Ricko		115.74	118.51	122.89	119.05
LSD $_{0.05}$		4.344			2.508
The interaction of bio- * chemical fertilizer					average of bio-
control		114.96	118.77	125.04	119.59
with		124.84	129.24	132.41	128.83
LSD $_{0.05}$		3.547			2.048

Table 4 : Effect of variety, bio- and chemical fertilizers on weight dry pod

variety	Bio-fertilizer	Chemical fertilizer (kg.ha^{-1})			Variety* bio-fertilizer
		0	40	80	
Local	control	6.450	7.300	7.475	7.075
	with	7.175	8.050	8.425	7.883
Luzdi	control	6.775	7.450	7.500	7.242
	with	7.675	8.100	8.000	7.925
Ricko	control	6.000	6.675	7.325	6.667
	with	7.125	7.425	7.750	7.433
Average of chemical fert.		6.867	7.500	7.746	
LSD $_{0.05}$		Chemical =0.2207 interaction= 5407			0.3122
The interaction of variety * chemical fertilizer					average of var.
Local		6.813	7.675	7.950	7.479
Luzdi		7.225	7.775	7.750	7.583
Ricko		6.563	7.050	7.538	7.050
LSD $_{0.05}$		0.3823			0.2207
The interaction of bio- * chemical fertilizer					average of bio-
control		6.408	7.142	7.433	6.994
with		7.325	7.858	8.058	7.747
LSD $_{0.05}$		0.3122			0.1802

Table 5 : Effect of variety, bio- and chemical fertilizers on biological yield (t.ha^{-1}).

variety	Bio-fertilizer	Chemical fertilizer (kg.ha^{-1})			Variety* bio-fertilizer
		0	40	80	
Local	control	9.112	10.371	11.165	10.216
	with	10.227	11.359	12.155	11.247
Luzdi	control	9.519	11.355	12.094	10.990
	with	10.195	12.387	13.136	11.906
Ricko	control	8.915	10.104	10.228	9.749
	with	9.446	10.702	11.097	10.415
Average of chemical fert.		9.569	11.046	11.646	
LSD $_{0.05}$		Chemical = 0.1837 interaction= 0.450			0.2598
The interaction of variety * chemical fertilizer					average of var.
Local		9.669	10.865	11.660	10.731
Luzdi		9.857	11.871	12.615	11.448
Ricko		9.181	10.403	10.662	10.082
LSD $_{0.05}$		0.3182			0.1837
The interaction of bio- * chemical fertilizer					average of bio-
control		9.182	10.610	11.162	10.318
with		9.956	11.483	12.129	11.190
LSD $_{0.05}$		0.2598			0.1500

Table 6 : Effect of variety, bio- and chemical fertilizers on dry seed yield (t.ha^{-1}).

variety	Bio-fertilizer	Chemical fertilizer (kg.ha^{-1})			Variety* bio-fertilizer
		0	40	80	
Local	control	2.609	3.367	3.573	3.183
	with	2.978	3.469	4.217	3.554
Luzdi	control	2.933	3.241	3.652	3.275
	with	3.225	3.836	3.949	3.670
Ricko	control	3.052	3.587	3.459	3.366
	with	3.145	3.575	4.126	3.615
Average of chemical fert.		2.990	3.512	3.829	
LSD $_{0.05}$		Chemical = 0.2136 interaction= 0.5232			0.3021
The interaction of variety * chemical fertilizer					average of var.
Local		2.793	3.418	3.895	3.369
Luzdi		3.079	3.538	3.800	3.472
Ricko		3.098	3.581	3.793	3.491
LSD $_{0.05}$		0.3700			0.2136
The interaction of bio- * chemical fertilizer					average of bio-
control		2.865	3.398	3.561	3.275
with		3.116	3.627	4.097	3.613
LSD $_{0.05}$		0.3021			0.1744

References

Al-Shahat, T.M.R. (2007). Bio-fertilizers and Organic Farming are Healthy Food and Clean Environment. Faculty of Agriculture - Ain Shams University. First Edition, Arab Thought Publishing - Cairo. 200.

Abbas, S.H. (2012). Performance Analysis to Genotypes Characters in broad bean under effect at Different Levels for the fertilization NPK. Kufa J. Agric. Sci., 4(2): 318–305.

Abdelmula, A.A. and Abuanja, I.K. (2007). Genotypic responses, yield stability, and association between characters among some of Sudanese faba bean (*Vicia faba* L.) genotypes under heat stress. Conference on International Agricultural Research for Development, October 9-11.

Alipour, N.; Sadeghi, S.M. and Sharifi, P. (2014). Effects of bio-and chemical fertilizers on growth and yield of faba bean (*Vicia faba* L.). Adv Biores. 5: 88-91.

Ara, N.; Rokonuzzaman, M. and Hasan, M.N. (2009). Effect of Bradyrhizobium and Azotobacter on growth and yield of mungbean varieties, J. Bangladesh Agric. Univ. 7(1): 7–13.

Badr, E.A.; Asal, M.W. and Gehan, A.A. (2013). Effect of sowing dates and biofertilizer on growth attributes, yield and its components of two faba bean (*Vicia faba L.*) cultivar. World Applied Sciences Journal, 28 (4): 494-498.

Badr, E.A.; Amany, A.; Bahr, G.A.A. and Asal, M.W. (2014). Response of Sweet Lupin (*Lupinus albus* L.) to Spraying with Molybdenum, Bio and Nitrogen fertilizer on Seed yield and quality. Middle East Journal of Agriculture Research, 3(2): 363-367.

Elkhatib, H.A. (2009). Growth and yield of common bean (*Phaseolus Vulgaris* L.) in response to rhizobium inoculation, nitrogen and molybdenum fertilization. Alex. Sci. Exch. J., 30(2): 319-332.

El-Shouny, K.A.; Abdel-Gawad, A.A.; El-Gind, A.M. and Sorour, H.A. (2001). Studies on phosphatic fertilization and irrigation of mung bean. ii- Individual effect of phosphaticfertilization, water regime and irrigation system on yield and quality. Arab Univ. J. Agri. Sci. Ain Shams Univ. Cairo. 9(1): 213-223.

Erum, S. and Bano, A. (2008). Variation in phytohormone production in Rhizobium strains at different altitudes of Northern Areas of Pakistan. Int. J. of Agric. Biol., 10(5): 563-540.

Rizk, A.F. and Shafeek, M.R. (2000). Response of growth and yield of (*Vicia faba* L.) plants to foliar and bio-fertilizers. Egypt J. Appl. Sci. 15(12): 652-670.

Gabr, S.M.; Elkhatib, H.A. and El-Keriawy, A.M. (2007). Effect of different biofertilizer types and nitrogen fertilizer levels on growth, yield and chemical contents of pea plants (*Pisum sativum* L.). J. Agric. & Environ. Sci. Alex. Univ., Egypt 6(2): 192-218.

Gitari, J.N. and Mureith, J.G. (2003). Effect of phosphorus fertilization on legume nodule formation and biomass production in Mount Kenya Region. East. Afr. Agri. J. 9: 183-187.

Huang, N.; Wang, W.; Yao, Y.; Zhu, F. and Chang, X. (2017). The influence of different concentrations of bio-organic fertilizer on cucumber fuzarium wilt and soil microflora alterations. Plos One, 12(2):1-17.

Ismail, R.H. (2002). Physiological studies on bio-fertilization in pea plants (*Pisum sativum* L.) under calcareous soil conditions. Ph.D. Thesis, Fac. Agric., Ain Shams. Univ., Egypt.

Khandelwal, R. (2012). Response of cowpea [*Vigna unguiculata* (L.) Walp] to nitrogen and phosphorus fertilizers and seed inoculations. Legume Res., 35: 235-238.

Gutierrez, N.; Avila, C.M.; Moreno, M.T. and Torres, A.M. (2008). Development of SCAR markers linked to zt-2, one of the genes controlling absence of tannins in faba bean, Australian Journal of Agricultural Research, 59: 62–68.

Nishita, G. and Joshi, N.C. (2010). Growth and yield response of chick pea (*Cicer arietinum* L.) to seed inoculation with Rhizobium sp. Nature and Science, 9: 232-236.

Qasim S.M.; Saleem, F.; Khan, M.; and Anjum, S.A. (2009). Performance of soybean (*Glycin max* L.) under different phosphorus levels and inoculation. Pak. J. Agri. Sci., 46(4):1-5.

Rasool, S. and Singh, J. (2016). Effect of Bio-fertilizers and Phosphorus on Growth and Yield of Lentil (*Lens culinaris* L.). Int. J. Adv. Agric. Sci. and Tech., 3(7): 35-42.

Alghamdi, S.S. (2009). Heterosis and Combining Ability in Diallel Cross of eight faba bean (*Vicia faba* L.) Genotypes. Asian Journal of Crops Science. 1(2): 66-76.

Shafeek, M.R.; Ali, A.H.; Asmaa, R. and Mahmoud (2016). Foliar application of amino acids and biofertilizer promote execution of broad bean plant (*Vicia faba* L.) under newly reclaimed land conditions. Int. J. Pharm. Tech. Res., 9(5): 100-109.

Shafeek, M.R.; Faten S.A. and Aisha, H.A. (2004). The productivity of broad bean plant as affected by chemical and/or natural phosphorus with different bio-fertilizer. J. Agric. Sci. Mansoura Univ., 29 (5): 2727-2740.

Singh, R. and Prasad, K. (2008). Effect of vermicompost, Rhizobium and DAP on growth, yield and nutrient uptake by chickpea. Journal of Food Legumes, 21: 112-114.

Solieman, T.H.; ElKhatib, H.A. and El-Araby, S.M. (2003). Effects of organic manure, mineral nitrogen and bio-fertilizer application on vegetative growth and chemical composition of pea (*Pisum sativum* L.). Zagazig J. Agric. Res. 30(3): 751-767.

Taiz, L. and Zeiger, E. (2006). Plant Physiology, fourth ed., Sinauer Associates, Sunderland, 2006.

Yadegari, M. (2009). Investigate the effects of dual inoculation with Rhizobium bacteria in the rhizosphere and plant growth enhancer PGPR on growth, yield and other characteristics of red bean plant. Ph.D. thesis Crop Physiology.