Annals of Agric. Sci., Moshtohor **ISSN 1110-0419**
Vol. 50(3) (2012), 303– 316 **http://annagricmoshj.com**

Effect of bio and mineral fertilizer on growth and productivity of pea

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Abstract

This experiment was carried out during the two successive winter seasons of 2009/2010 and 2010/2011 at clay loam soil in the farm of Faculty of Agriculture, Moshtohor, Benha University, Kalubia governorate, Egypt to investigate the effect of N, P fertilizer levels and some bio-fertilizer types which included Rhizobium, Phosphorein and Rhizobium plus Phosphorein in combination with mineral N and P fertilizers on vegetative growth and chemical composition of plant foliage as well as green pods yield and its components and dry seeds yield of pea plants cv. Master B. These treatments were arranged in complete randomized blocks design with four replicates. The results revealed that application of 100% and 50% of the recommended dose for both N at (40 and 20 kg N/fed.) and P at (31 and 15.5 kg P_2O_5/fed.) in the form of combination with inoculation the seed by Rhizobium pluse Phosphorein significantly increased stem length, number of leaves and branches/plant, fresh, dry weight/plant, But delayed flowering, Also, it showed an increment in photosynthetic pigments of leaves (chlorophyll a, b and a+b as well as carotenoids), N, P, K and crude protein percentage of foliage, number and weight of pods/plant, total green pod yield, average pod length, pod diameter, pod weight, number and weight of seeds/pod, netting percentage, weight of 100 dry seeds, N, P, K and protein percentage in pea seeds and dry seed yield followed by (Rhizo. + Phosp. + 25% of N + P_2O_5), (Rhizo.+ 100% N), (Rhizo. + 50% N), (Phosp. + 25% P_2O_5), (Rhizo. +25% N), mineral fertilizers with combination of nitrogen and phosphorus in a recommended levels then bio-fertilizers (Rhizobium and Phosphorein) compared to the both seasons.

Key words: Pea, Bio-fertilizer, Rhizobium, Phosphorein, NP fertilizer

Introduction

It has been recognized that fertilizers are effective means to increase the yield of vegetable crops to reduce the shortage in food supplies especially in countries with population of high density.

Bio-fertilizers are microorganisms that help plants to grow by increasing the quantity of nutrients. Since these fertilizers contain living microorganisms, it increases or promotes the supply of important nutrients crucial for the overall productivity of the soil. An increasing number of farmers and agriculturists are turning to the use of bio-fertilizers as these are gentler on the soil as against chemical fertilizers (Mahdi *et al.* 2010).

Nitrogen and phosphorus fertilization are among the most important agricultural treatments that affecting the yield of unit area. Nitrogen is the most commonly used mineral nutrient. It is important for protein production. It plays a pivotal role in many critical functions (such as Photosynthesis) in the plant and is a major component of proteins these amino acids are then used in forming protoplasm, the site of cell division and plant growth. Nitrogen is necessary for enzymatic reactions in plants since all plant enzymes are proteins. It is a necessary component of several vitamins, e.g., thiamine, niacin and riboflavin nitrogen is part of the nucleic acids (DNA and RNA) (Marschner, 1995). Phosphorus is one of the essential elements needed for its favorable effect on photosynthesis (Repka, 1979), its inclusion in vital compounds (Bidwell, 1979; Edmond *et al*, 1981), its importance in enzymatic system and its role in division and development of meristematic tissues (Bieleski, 1973) as for organic and inorganic fertilizers,Yagodin (1984).

Therefore, the present study aimed to investigate the effect of NP fertilization with three treatments of Bio-fertilizers Rhizobium, Phosphorein and their mixture on pea plant growth , chemical composition and green pod yield and its components as well as dry seed yield and seeds quality. Such study aimed also to decrease the pollution resulting from using mineral fertilizers by the application of bio-fertilizers.

Materials and Methods

The present experiment was conducted in the farm of Faculty of Agriculture, Moshtohor, Benha University, Egypt to evaluate the effect of NP fertilizers levels and three biofertilizers on growth and chemical constituents of plant foliage as well as green pod and dry seed yield on pea (*Pisum sativum L) cv. Master B.*

The soil of the experimental field was clay loam in texture (3.41% coarse sand, 16.79% fine sand, 34.85% silt and 40.90% clay) having 2.87 $CaCO_3$, 82.51 ppm available N, 2.00 ppm available P, 219.85 ppm exchangeable K with 7.2 PH. Maximum mean

temperature rose up to 25.37 and 26.64^{O}C, while minimum mean temperature gone up to 5.01 and 5.15^{O}C during first and second winter season of crop, respectively. Relative humidity was also remained more or less similar during both years maximum mean humidity rose up to 83% and 85% while minimum humidity gone up to 72% and 71% during first and second winter season of crop, respectively. Seeds were sown on November 1st, 2009/2010 and November 6th, 2010/2011, respectively on both sides of ridge 4 m long and 60 cm wide. Seeds were drilled at spacing averaged 7 cm apart. Each experimental plot consisted of 4 ridges. The area of each plot was 9.6m^2.

Seeds were inoculated directly before sowing with Rhizobium *(Rhizobium leguminosarum)* or Phosphorien *(Bacillus megatherium var. phosphaticum*) or their mixture. These spores were originally extracted by the Department of Microbiology, National Research Center, Dokki, Cairo. Then seeds were sown in the moderately moist soil. Nitrogen was applied in the form of ammonium sulfate (20.6% N), Phosphorus in the form of calcium superphosphate (15.5% P_2O_5) and potassium in the form of potassium sulfate (48%K_2O) at rate of 50 kg K_2O/ fed. The different amounts of fertilizers were added at two equal doses three and six weeks after seed sowing.

The current study was included 16 treatments as follows:

1- Control (without any fertilizers addition or inoculation with biofertilizers).
2- 40 Kg N/fed + 31 Kg P_2O_5 /fed.
3- 0 Kg N/fed. +٠ Kg P_2O_5 /fed. + Rhizobium at 300 g/fed.
4- 0 Kg N/fed. + ٠ Kg P_2O_5/fed. + Phosphorien at 300 g/ fed.
5- 0 Kg N/fed. + ٠ Kg P_2O_5 /fed. + Rhizobium + Phosphorien at 300 g for each of them/fed.
6- 0 Kg N/fed. +31 Kg P_2O_5 /fed. + Rhizobium at 300 g/fed.
7- 10 Kg N/fed. +31 Kg P_2O_5 /fed. + Rhizobium at 300 g/fed.
8- 20 Kg N/fed. + 31 Kg P_2O_5 /fed. + Rhizobium at 300 g/fed.
9- 40 Kg N/fed. + 31 Kg P_2O_5 /fed. + Rhizobium at 300 g/fed.
10- 40 Kg N/fed. + ٠ Kg P_2O_5/fed. + Phosphorein at 300 g. / fadden.
11- 40 Kg N/fed. + 7.75 Kg P_2O_5/fed. + Phosphorein at 300 g/fed.
12- 40 Kg N/fed. + 15.5 Kg P_2O_5/fed. + Phosphorein at 300 g/fed.
13- 40 Kg N/fed. + 31 Kg P_2O_5/fed. + Phosphorein at 300 g/fed.
14- 10 Kg N/fed. + 7.75 Kg P_2O_5 /fed. + Rhizobium + Phosphorein at 300 g for each of them/fed.
15- 20 Kg N/fed. + 15.5 Kg P_2O_5 /fed. + Rhizobium +Phosphorein at 300 g for each of them/fed.
16- 40 Kg N/fed. + 30 Kg P_2O_5 /fed. + Rhizobium+ Phosphorein at 300 g for each of them/fed.

Data recorded.

a- Vegetative growth characters.

A random sample of five plants from each experimental plot was taken at full blooming stage i.e., after two weeks from the second addition of mineral fertilizers. The following data were recorded: Stem length. It was measured from the highest point of the plant up to the first node above the soil surface, Number of branches and leaves per plant. Fresh weight per plant, it was calculated for each of stem, leaves and total fresh weight of plant. Dry weight per plant, the above ground vegetative parts were oven dried at 70^{o}C to a constant weight and then the dry weight per plant was calculated.

b- Flowering behavior.

Number of days from sowing till the anthesis of the first flower was determined in a representative sample of three plants which were labeled at each plot for this purpose.

c- Chemical constituents of plants foliage.

1. Chlorophyll a, b and total chlorophyll (a+b) as well as carotenoids were colorimetrically determined as described by A.O.A.C (1970) in fresh samples from the fourth upper leaf at 7 weeks after sowing.
2. Each of N, P and K were determined in the dry matter of the different plant parts for plant foliage. Total Nitrogen, it was determined in the digested dry matter of plant leaves using microkjeldahl method according to Pregl (1945). The Phosphorus was determined by using spectrophotometer method as described by John (1970). The Potassium was determined by using flame photometer method as described by Brown and Lilleland (1946).

d. Green pod yield and its components.

At harvest time (75 days after seed sowing), reproductive characteristics were recorded by using number and weight of green pod taken from each plot, hence, average number of green pods/plant, green pods yield/plant and total yield of green pods (ton/fed.) were calculated.

e. Physical and chemical fruit quality.

In order to record the physical pod characters, random samples of 20 pods were taken from every plot and the following data were recorded: Average pod length, pod diameter and pod weight, number of seeds/pod, fresh seed weight per pod, netting percentage (total weight of green seeds/total weight of green pods X 100), weight of 100 seeds (seed index), and dry seeds yield/fed.

For chemical determination, representative sample of 100 g. of green seeds were taken from each treatment and oven dried and total nitrogen, phosphorus and potassium were determined. The previously determined total nitrogen content in dry matter of plant foliage and seeds was used for calculating total crude protein percentage in seeds by multiplying N-values by 6.25.

All the obtained data were statistically analyzed according to Gomez and Gomez (1984).

Results and Discussion

Effect of nitrogen, phosphorus fertilizer levels and bio-fertilizer inoculation as well as their combination on:

a. Vegetative growth characteristics:

Results in Table 1 show the effect of NP fertilizer, biofertilizer types and its combination on pea plants morphological characters expressed as stem length, leaves number/plant, number of branches, fresh and dry weight/plant in the two seasons of study. Such data indicate that there was a significant increase in the aforementioned parameter with NP fertilizer over the control. Such trend was noted by different workers among them Ismail (2002), Dawa *et al*. (2003), Gabr *et al*. (2007) and Youssef (2007). Favorable effects of NP application on vegetative growth could be expected, since nitrogen is known as an essential plant nutrient and plays a major role in nucleic acids and protein synthesis, cell division and elongation and protoplasm formation (Marschner, 1995). Also, the promoting effect of phosphorus fertilizer on growth characters may be due to the role of phosphorus in the enzyme systems necessary for energy transform in photosynthesis and respiration as well as its essential role in division and development of meristemic tissues. In addition, phosphate leads to enhancing photosynthesis (Repka, 1979).

Concerning the effect of biofertilizer types, the same data in Table 1 showed that there were a significant increase in vegetative growth characteristics due to using biofertilizer types either rhizobium or phosphorein compared with the control (uninoculated seeds) in the two seasons. In addition, it was observed that using the mixture of rhizobium and phosphorein was more effective compared with any one alone. Obtained results were in agreement with previous investigations reported by Ismail (2002), Dawa *et al*. (2003), Gabr *et al*. (2007),Youssef (2007), Yifru *et al*. (2007) and Mishra *et al*. (2010). These observation might indicate that microorganisms as rhizobium which has the nitrogenase enzyme that combines gaseous nitrogen with hydrogen to produce ammonia (Mishra *et al.* 2010) and phosphorein which increasing the availability of P in soil. Also, they have ability to supply the pea plants with phytohormones. All of these minerals and hormones could increase the growth of plants (EL-Shmma, 2000).

The combination between the biofertilizer types and NP fertilizers were significantly increased the vegetative growth characteristics in the two seasons. The highest values in these parameters were obtained from using rhizobium plus phosphorein with 50% or 100% NP fertilizers. Similar finding was demonstrated by Ismail (2002), Gabr *et al.* (2007), Yossef (2007) and Jitender (2011). Obtained results might be due to the seed inoculation with biological fertilizers in addition to N application was found to increase roots nodulation. Moreover, phosphate dissolving bacteria presses the ability to bring insoluble phosphates in soluble forms by securing organic acids such as formic, acetic and lactic acid. These acids lower the pH and bring about the dissolution of bonds forms of phosphate and render them available for growing plants (Sherif *et al.*, 1997).

b. flowering behavior.

The effect of NP fertilizer and biofertilizer types on flowering time of pea plants was given in Table 2. Data revel that NP fertilizers delayed the flowering compared to the control. These results were in the same direction as reported by Gabr *et al.* (2007) on pea and Kamel (2006) on sweet corn. Such results might be attributed to the stimulation effects of nitrogen on the vegetative growth characters that, consequently, resulted in delaying the flowering Gabr *et al.* (2007).

Flowering traits, listed in Table 2 indicate that the inoculation of pea seeds with the mixed biofertilizers or with rhizobium alone caused a significant delay of flowering. While, the inoculation of pea seeds with phosphorein pushed plants to flower earlier compared with the control in both seasons. Similar results were obtained by Dawa *et al.* (2003), Gabr *et al.* (2007) on pea and Zaman *et al.* (2011) on chickpea.

In this respect, the combination between the biofertilizer types and NP fertilizers delayed the flowering compared to the biofertilizer types or the control. The obtained results are in the same direction reported by Gabr *et al.* (2007) and Jitender (2011). These results could be attributed to the effects of the symbiotic nitrogen fixing bacteria on the morphology and physiology of the root system which promoted the vegetative growth to continue for a longer time and hence delayed flowering (Gabr *et al.*, 2007). Also, phosphorein is increased the availability of P in soil which important in metabolic process, blooming and flower development, because it is a main constituent of energy compounds (ATP and ADP), phospholipids, nucleic acids, nucleotides and enzymes (Dhillon, 1978).

Table1. Effect of biofertilizers, nitrogen and phosphorus mineral fertilizers and their combination on vegetative growth characteristics

Season	**2009 - 2010**					**2010 - 2011**				
Treatments	Stem length (cm)	Leaves number	No.of branches	Fresh weight (g)	Dry weight (g)	Stem length (cm)	Leaves number	No.of branches	Fresh weight (g)	Dry weight (g)
Control	28.39	6.06	1.20	27.54	3.76	29.65	8.00	1.06	33.64	4.33
100% N+P	43.94	11.06	1.75	46.79	5.98	41.43	12.44	1.63	50.98	6.26
Rhizobium	31.59	7.06	1.42	32.42	4.64	35.33	8.64	1.4I	37.38	5.42
Phosphorien	32.75	6.81	1.42	30.79	4.42	33.93	8.59	1.45	36.70	5.32
Rhizo. + 0% N	37.87	9.13	1.44	36.56	5.28	40.35	10.56	1.47	41.50	5.13
Rhizo. + 25% N	45.02	11.06	1.94	52.39	7.52	47.03	12.44	1.81	57.30	6.59
Rhizo. + 50% N	51.89	13.00	2.94	59.04	8.46	53.88	14.38	2.69	63.90	7.76
Rhizo. + 100 %N	52.62	12.88	2.75	58.95	8.43	54.35	14.31	2.75	64.03	7.67
Phosph.+ 0% P	43.72	9.38	1.69	38.69	5.54	43.38	10.81	1.50	43.65	5.39
Phosph. + 25% P	43.85	10.94	1.88	50.37	7.28	44.03	12.31	1.69	55.31	6.41
Phosph. + 50% P	47.44	12.06	2.38	53.08	7.63	47.68	13.44	2.25	58.75	7.20
Phosph. + 100% P	48.02	12.50	2.63	53.97	7.73	47.90	13.88	2.44	58.92	7.47
Rhizo.+ phosp.+ 0% N,P	41.24	11.00	1.63	37.82	5.42	43.48	12.38	1.50	42.73	6.46
Rhizo.+ phosp.+ 25% N,P	52.92	13.31	2.19	61.44	8.80	55.93	14.69	2.06	66.41	8.03
Rhizo.+ phosp.+ 50% N,P	58.19	13.63	2.81	65.94	9.52	60.68	15.06	2.81	71.15	9.22
Rhizo.+phosp.+100% N,P	57.87	13.75	2.88	66.48	9.55	60.35	15.19	2.75	71.40	9.04
L.S.D at 0.05	3.308	0.58	0.23	3.03	0.47	3.18	0.49	0.266	2.84	0.93

Table2. Effect of bio-fertilizer, nitrogen and phosphorus mineral fertilizers and their combination on flowering time of pea plants

Season	**2009 - 2010**	**2010 - 2011**
Treatments	No. of days to the first flower	No. of days to the first flower
Control	30.50	32.50
100% N+P	34.25	35.00
Rhizobium	32.50	34.00
Phosphorien	30.50	31.25
Rhizo. + 0% N	32.25	34.75
Rhizo. + 25% N	33.25	35.50
Rhizo. + 50% N	33.25	35.50
Rhizo. + 100 %N	33.50	35.75
Phosph.+ 0% P	32.00	33.50
Phosph. + 25% P	31.75	34.50
Phosph. + 50% P	31.75	33.25
Phosph. + 100% P	31.75	33.00
Rhizo.+ phosp.+ 0% N,P	34.25	35.25
Rhizo.+ phosp.+ 25% N,P	34.25	35.50
Rhizo.+ phosp.+ 50% N,P	34.50	35.75
Rhizo.+ phosp.+ 100% N,P	35.50	36.25
L.S.D at 0.05	1.07	0.86

Table3. Effect of biofertilizers, nitrogen and phosphorus minerals fertilizers and their combination on photosynthetic pigments of pea leaves

Season	**2009 – 2010**				**2010 - 2011**			
Treatments	Chlorophyll A mg/100 g f.w)	Chlorophyll B (mg/100 g f.w)	Total chlorophyll (a+b) (mg/100 g f.w)	Carotenoids (mg/100 g f.w)	Chlorophyll A (mg/100g f.w)	Chlorophyll B (mg/100 g f.w)	Total chlorophyll (a+b) (mg /100 g f.w)	Carotenoids (mg / 100 g f.w)
Control	60.20	32.77	92.97	53.62	63.01	34.63	97.64	53.62
100% N+P	70.11	41.21	111.32	55.51	72.13	43.18	115.30	63.84
Rhizobium	66.16	36.59	102.75	54.41	67.58	38.50	106.08	58.43
Phosphorien	64.59	35.02	99.60	53.03	65.33	36.95	102.28	55.94
Rhizo. + 0% N	68.32	39.27	107.59	58.12	70.25	41.20	111.45	61.11
Rhizo. + 25% N	73.08	43.93	117.01	60.38	75.03	45.88	120.90	63.38
Rhizo. + 50% N	75.01	47.19	122.20	62.45	77.03	48.7	125.73	65.38
Rhizo. + 100 %N	75.51	47.99	123.50	62.51	80.45	51.93	132.38	65.47
Phosph.+ 0% P	70.53	41.38	111.91	58.72	72.43	43.33	115.75	61.66
Phosph. + 25% P	70.70	42.66	113.36	59.00	72.75	44.68	117.43	61.99
Phosph. + 50% P	71.60	44.89	116.49	61.59	75.10	47.83	122.93	64.59
Phosph. + 100% P	72.27	45.71	117.98	62.48	76.28	51.50	127.78	65.51
Rhizo.+ phosp.+ 0% N,P	71.97	42.56	114.53	60.18	74.51	44.58	118.51	63.19
Rhizo.+ phosp.+ 25% N,P	76.77	45.61	122.38	61.73	76.41	47.55	126.24	64.69
Rhizo.+ phosp.+ 50% N,P	79.12	49.54	128.66	63.65	80.55	51.48	132.03	66.61
Rhizo.+ phosp.+ 100% N,P	79.70	50.51	130.21	63.41	82.15	52.48	134.63	66.32
L.S.D at 0.05	1.87	1.59	2.69	1.35	1.63	1.28	2.40	1.21

C- Chemical composition of plant foliage:

Photosynthetic pigments:

Data recorded in Table 3 show the effect of NP fertilizer, seed inoculation with bio-fertilizers (rhizobium and phosphorein) and their combination on photosynthetic pigments (chlorophyll a, b and carotenoids) during both seasons of study. Results in current study indicate clearly that all photosynthetic pigments of pea (chlorophyll a, b and a+b as well as carotenoids) were significantly affected by NP fertilizers compared to the control in both seasons.

These results are in accordance with those reported by Mansour (2000), Gabr *et al* (2007) and Youssef (2007). The increments in chlorophyll and carotenoids with the addition of NP fertilizers may be probably due to that nitrogen is a constituent of chlorophyll molecule. Phosphorus has enhancing influence on photosynthesis and respiration (Edmond *et al.* 1981).

Concerning the effect of biofertilizer types, the same data in Table 3 show significant increase in this characteristics due to using biofertilizer types either rhizobium or phosphorein compared with the control. Similar results were obtained on pea by Zhagloul *et al.* (1988), EL-Mansi *et al.* (2000), Gabr *et al.* (2007) Youssef (2007), on spinach El-Assiouty and Abo-Sedera (2005) on *Vigna unguiculata.,* Arumugam *et al.* (2010). This increase may be due to an increase in stomatal conductance, photosynthesis, transpiration and enhanced plant growth (Rajasekaran *et al.,* 2006) or due to the presence of large and more numerous bundle sheath chloroplasts in the inoculated leaves (Krishna and Bagyaraj, 1984).

The combination between the biofertilizer types and NP fertilizers show that the photosynthetic pigments were significantly increased with using rhizobium, phosphorein plus NP fertilizers more than biofertilizer types or chemical fertilization alone or the control in the two seasons. Similar findings were demonstrated by Ismail (2002) and Gabr *et al.* (2007) on pea and El-Assiouty and Abo-Sedera (2005) on spinach.

Mineral and organic constituents:

Data tabulated in Table 4 show the effect of NP fertilizer and bio-fertilizer types as well as their combination on NPK and crude protein, percentage in plant foliage during both seasons of study. Results reveal that the highest increments in the concentration of N, P, K and crude protein in pea plants foliage were obtained by application of N and P fertilizers compared to the control during both growing seasons of this study. These results coincide with those reported by Kanaujia *et al*., (2000), Mansour (2000), Dawa et al. (2003) and Sarg and Sawsan (2004). Such enhancing effect of N and P fertilizers in this concern may be due to the increasing availability of N and P in growth media and the high absorbing efficiency of pea roots due to the application of such fertilizers (Mansour, 2000).

Table4. Effect of biofertilizers, nitrogen and phosphorus minerals fertilizers and their combination on N, P, K and crude protein percentage of pea foliage

Season	**2009 - 2010**				**2010 - 2011**			
Treatments	N%	P%	K%	Total crude protein %	N%	P%	K%	Total crude protein %
Control	1.50	0.32	0.72	9.34	1.73	0.38	1.02	10.83
100% N+P	3.03	0.44	1.67	19.31	3.34	0.48	1.85	20.84
Rhizobium	2.15	0.39	0.87	12.83	2.26	0.40	1.13	14.13
Phosphorien	1.68	0.41	1.04	10.78	1.95	0.44	1.34	12.16
Rhizo. + 0% N	2.45	0.39	1.13	14.27	2.52	0.44	1.20	15.72
Rhizo. + 25% N	3.17	0.42	1.36	19.13	3.27	0.47	1.41	20.42
Rhizo. + 50% N	3.31	0.44	1.54	20.52	3.51	0.49	1.58	21.91
Rhizo. + 100 %N	3.45	0.45	1.66	22.66	3.73	0.50	1.70	23.28
Phosph.+ 0% P	2.42	0.44	1.52	15.22	2.66	0.52	1.56	16.61
Phosph. + 25% P	2.93	0.51	1.53	17.70	3.08	0.58	1.63	19.23
Phosph. + 50% P	3.07	0.55	1.71	18.58	3.18	0.62	1.77	19.88
Phosph. + 100% P	3.15	0.60	1.73	19.03	3.28	0.66	1.81	20.48
Rhizo.+ phosp.+ 0% N,P	2.61	0.50	1.66	15.72	2.74	0.57	1.73	17.11
Rhizo.+ phosp.+ 25% N,P	3.20	0.59	1.70	19.50	3.35	0.66	1.80	20.91
Rhizo.+ phosp.+ 50% N,P	3.32	0.63	1.90	21.44	3.65	0.69	1.95	22.81
Rhizo.+ phosp.+ 100% N,P	3.68	0.64	1.99	21.88	3.85	0.71	2.04	24.05
L.S.D at 0.05	0.16	0.045	0.127	0.998	0.13	0.014	0.10	0.81

The same data presented in Table 4 clearly show that the concentration of N, P, K and crude protein in pea plant foliage were significantly affected by using biofertilizer types either rhizobium or phosphorein compared with the control. In this connection using the mixture of rhizobium plus phosphorein reflected the highest N, P, K and crude protein percentage compared with using each of them alone. Similar

results were obtained by Kanaujia *et al.* (2000), Geneva *et al.* (2006) and Gabr *et al.* (2007).

The combination between mineral and biofertilizer types significantly increased the N, P, K and crude protein percentage of pea plant foliage. These results were true in the first and second seasons. In this regard, the combination between 50 and 100% of the recommended dose of N and P with the mixture of tested bio-fertilizers exhibited the highest values for all assayed mineral and organic constituents during both seasons of growth. These results could be attributed to the increasing N and P levels with microorganisms like rhizobium dissolving microorganisms like phosphorein increase the soil fertility and absorbing capacity of roots which in turn increase the foliage contents of N, P, K and protein contents. Similar results were obtained by Sarg and Sawsan (2004) on sweet pea, EL-Shamma (2000) on dry bean and Fatima *et al.* (2007) on soybean.

Yield and its components:

Data presented in Table 5 show the effect of NP fertilizers ,bio-fertilizer rhizobium and phosphorein as well as their combination on total produced yield and its components i. e., number and weight of pods / plant, total green pod yield as well as dry seeds yield / fed. In this regared, all previous characters were significantly increased by application of N and P fertilizers at 100% of the recommended dose compared to the control during both growing seasons of this study. Similar findings were demonstrated by Ali (2000), Mansour (2000), Ismail (2002), Sarg and Sawsan (2004), Elkhatib *et al.* (2007), Gabr *et al.* (2007) on pea and Haque (2011) on tomato. The improving effect of NP fertilizers might be due to excess supply of available nutrients through the application of NP fertilizers which connected with good plant growth (Table 1) the highest photosynthetic pigments content in plant leaves (Table 2) and the highest minerals content (Table 3). Hence, such vigorous growth, good nutritional plant status and higher photosynthetic pigments content resulted, in turn in increasing the amount of metabolites synthesized and dry matter accumulation by the plant and also in the increase in average pod weight, green pod yield and its components.

With regard to the effect of biofertilizer types, the same data in Table 5 show significant increase in total green pod and dry seed yield/fed. as well as yield components due to using biofertilizer types either rhizobium or phosphorein compared with the control in the two seasons. In addition, the highest stimulating effect was recorded in case of inoculation the seed pre-sowing with mixture of rhizobium and phosphorein compared with using each of them solely. Results obtained in current investigation are in harmony with those of Ismail (2002), Ali (2003), Dawa *et al.* (2003) and Gabr *et al.* (2007), Yifru *et al.* (2007) and Mishra *et al.* (2010) all working on pea, Hamed (2003) on faba bean, Fatma and Abdo (2003) on mung bean and Zaman *et al.* (2011) on chickpea.

In this concern, data presented in Table 5 clearly show that the combination between mineral (NP) and biofertilizer types significantly increased the total produced yield and its components either per plant or feddan. Similar findings were demonstrated by Sarg and Sawsan (2004), Elkhatib *et al.* (2007), Gabr *et al.* (2007) and Jitender (2011) all working on pea, Fatma and Abdo (2003) on mung bean, and EL-Gizawy and Mehasen (2009) on faba bean. These results might be expected on the basis that the different studied bacterial inoculants, probably, favored one or more of the beneficial influences, N_2 fixation, acquisition of P and various micro-nutrients due to production of chelators and organic acid, producing adequate amounts of indole acetic acid which affect growth, morphology and physiology of roots and secretion of fungistic substances responsible for the inhibition of some pathogens like Alternaria and fusarium (Martin *et al.*, 1989 and Jagnow *et al.*, 1991).

Physical pods characteristics:

Data recorded in Table 6 show the effect of N and P fertilizer, bio-fertilizers type and their combination of physical green pod characters expressed as average pod length, pod diameter, pod weight, number and weight of seeds/pod, netting percentage and weight of 100 dry seeds during both seasons of study. In this respect, the application of mineral fertilizer, i.e., N and P at the recommended dose significantly increased all studied physical pod characters of pea expressed as average pod length, pod diameter, pod weight, number and weight of seeds/pod, netting percentage and weight of 100-seeds compared with the control. Such enhancing effect in all measured physical pod characters as a result of using mineral fertilizers was agree with those reported by Ali (2000), Mansour (2000), Ismail (2002), Sarg and Sawsan (2004), Elkhatib *et al.* (2007) on pea and Elkhatib *et al.* (2009) on common bean. The favorable effect of N and P compound fertilizers may be directly owing to its simulative effect on plant vegetative growth as indicated in Table 1.

Concerning the effect of biofertilizer types, the same data in Table 6 showed significant increase in all measured pod traits due to using biofertilizer types either rhizobium or phosphorein compared with the control (uninoculated seeds) in the two seasons. Furthermore using the mixture of tested bio-fertilizers reflected the highest values compared with using each of them alone. Obtained results were in harmony with those of Ismail (2002), Sarg and Sawsan (2004) and Mishra *et al.* (2010).

Table 5. Effect of biofertilizers, nitrogen and phosphorus minerals fertilizers and their combination on total pea yield and its component

Season	**2009 – 2010**					**2010 - 2011**				
Characters / **Treatments**	No. of pod/plant	Fresh pod weight (g)	Weight of green pods/plot (Kg)	Weight of green pods/fed. (ton)	Total dry seed yield Kg/fed.	No. of pod / plant	Fresh pod weight/ plant (g)	Weight of green pods/plot (Kg)	Weight of green pods/fed. (ton)	Total dry seed yield Kg/fed.
Control	4.00	3.12	1.80	1.574	384.29	4.23	13.95	2.02	1.77	429.07
100% N+P	7.80	4.61	4.85	4.239	844.92	7.90	38.45	5.16	4.52	909.78
Rhizobium	4.73	3.86	2.69	2.358	478.34	5.05	20.90	3.00	2.62	560.01
Phosphorein	4.65	3.48	2.47	2.161	452.59	4.85	17.64	2.80	2.45	505.80
Rhizo. + 0% N	6.35	4.14	3.12	2.726	498.93	6.50	28.72	3.38	2.95	568.47
Rhizo. + 25% N	8.05	5.86	4.85	4.246	792.75	8.05	49.64	5.09	4.46	880.26
Rhizo. + 50% N	8.58	6.08	5.54	4.848	990.66	8.60	54.70	5.80	5.08	1094.94
Rhizo. + 100 %N	8.65	6.06	5.61	4.911	1012.26	8.70	55.12	5.88	5.14	1103.19
Phosph.+ 0% P	6.80	4.59	3.57	3.128	585.06	6.88	33.57	3.83	3.35	666.68
Phosph. + 25% P	7.40	4.86	4.06	3.553	679.41	7.50	38.39	4.32	3.78	773.76
Phosph. + 50% P	8.30	5.20	4.81	4.207	729.75	8.25	45.48	5.07	4.44	827.76
Phosph. + 100% P	8.38	5.13	4.88	4.268	819.00	8.33	45.44	5.15	4.50	903.00
Rhizo.+ phosp.+ 0% N,P	7.18	4.86	4.02	3.515	677.25	7.30	37.35	4.28	3.75	773.49
Rhizo.+ phosp.+ 25% N,P	8.45	6.37	5.32	4.653	916.95	8.45	56.25	5.54	4.85	1015.83
Rhizo.+ phosp.+ 50% N,P	9.05	6.54	6.17	5.399	1015.68	9.05	61.61	6.42	5.62	1089.45
Rhizo.+ phosp.+ 100% N,P	9.22	6.53	6.28	5.497	1090.11	9.05	62.61	6.53	5.71	1175.58
L.S.D at 0.05	0.35	0.34	0.395	0073	65.14	0.31	3.35	0.41	0.08	63.72

Table6. Effect of biofertilizers, nitrogen and phosphorus minerals fertilizers and their combination on physical fresh pod characteristics

Season	**2009 - 2010**							**2010 - 2011**						
Characters / **Treatments**	Fresh pod length (cm)	Fresh pod diameter (cm)	Fresh pod weight/ plant (g)	No. of seeds/ pod	Fresh seed weight/ pod (g)	Netting %	Seed index (weight of 100 seeds/g)	Fresh pod length (cm)	Fresh pod diameter (cm)	Fresh pod weight (g)	No. of seeds/ pod	Fresh seed weight/ pod (g)	Netting %	Seed index (weight of 100 seeds/g)
Control	5.19	1.11	12.50	4.10	1.16	37.25	18.19	6.15	1.14	3.30	4.60	1.37	41.67	19.28
100% N+P	7.16	1.33	35.96	7.35	2.13	46.26	23.40	8.12	1.38	4.87	7.80	2.44	50.12	25.36
Rhizobium	5.78	1.15	18.23	5.00	1.60	41.41	22.27	6.73	1.28	4.14	5.35	1.87	45.12	24.10
Phosphorein	5.66	1.18	16.20	4.70	1.37	40.30	20.77	6.57	1.22	3.64	5.15	1.60	44.08	21.35
Rh. + 0% N	6.51	1.24	26.29	6.40	1.79	43.20	21.53	7.52	1.30	4.42	6.80	2.08	46.97	23.46
Rh. + 25% N	8.11	1.37	47.15	8.60	2.56	43.80	24.76	9.25	1.43	6.17	9.05	2.93	47.59	26.64
Rh. + 50% N	9.31	1.42	52.13	9.05	2.86	46.94	27.31	10.31	1.48	6.36	9.50	3.23	50.71	29.28
Rh. + 100 %N	9.41	1.41	52.47	9.30	2.84	46.88	27.85	10.38	1.49	6.33	9.70	3.20	50.63	29.79
Phosph.+ 0% P	7.01	1.26	31.18	7.08	1.96	42.69	23.06	7.89	1.33	4.88	7.33	2.27	46.54	25.02
Phosph. + 25% P	7.65	1.28	35.91	7.50	2.15	44.31	23.26	8.59	1.36	5.12	7.85	2.47	48.19	25.29
Phosph. + 50% P	8.34	1.34	43.11	8.10	2.36	45.47	26.19	9.66	1.42	5.52	8.55	2.72	49.39	28.25
Phosph. + 100% P	8.71	1.39	42.93	8.35	2.34	45.66	26.83	9.81	1.46	5.46	8.75	2.71	49.57	28.84
Rh.+ phosp.+ 0% N,P	7.72	1.26	34.87	7.20	2.18	44.93	26.11	8.70	1.35	5.12	7.55	2.49	48.77	28.14
Rh.+ phosp.+ 25% N,P	8.73	1.38	53.82	9.20	2.97	46.62	26.26	9.85	1.47	6.63	9.55	3.35	50.39	28.23
Rh.+ phosp.+ 50% N,P	9.65	1.41	59.13	9.50	3.25	49.69	30.32	10.62	1.50	6.81	9.90	3.64	53.47	32.28
Rh.+ phosp.+ 100% N,P	9.72	1.45	60.21	9.55	3.25	49.85	30.09	10.75	1.53	6.83	9.95	3.64	53.62	32.16
L.S.D at 0.05	0.38	0.06	3.43	0.48	0.18	1.36	.27	0.36	0.06	0.33	0.34	0.01	1.33	.15

The combination between mineral and biofertilizer types were significantly increased all of these previous pod physical characteristics in the two seasons. These results might be explained on basis that promoting effects of biofertilizer and minerals fertilizers together on growth of pea plants which were reflected on the increasing of pod physical characteristics. Many investigators, working on different vegetable crops, emphasized the beneficial effects of the combination between inoculation with biofertilizers and mineral fertilizers application as Sarg and Sawsan (2004), Elkhatib *et al*. (2007) and Jitender (2011) on pea and Merghany (1999) on snap bean, EL-Shamma (2000) on dry bean, Fatma and Abdo (2003) on mung bean and EL-Gizawy and Mehasen (2009) on faba bean.

Seed chemical quality characteristics:

Data in Table 7 showed the effect of mineral NP fertilizer and biofertilizer types and their combination on chemical seed constituents. In this respect, the concentration of N, P, K and crude protein in pea seeds was significantly increased by application of N and P fertilizers compared to the control during both growing seasons of this study. Similar results were obtained by Mansour (2000), Ismail (2002), Elkhatib *et al*. (2007), and Youssef (2007) on pea, Elkhatib *et al.* (2009) on common bean, and Rugheim and Abdelgani (2012) on faba bean. Such improving effect of the NP fertilizers is mainly attributed to the enhancing effect of these NP fertilizers on photosynthesis assimilation rate, increasing the absorption of NPK by roots and accumulation of it in morphological parts (Table, 1) and consequently in produced seeds.

Such data in Table 7 clearly show that the concentration of N, P, K and crude protein in pea seeds was significantly affected by using biofertilizer types either rhizobium or phosphorein compared with the control. In this respect using their mixture reflected the highest concentration for all assayed chemical constituents of seed compared with each of them alone. Similar results were obtained by EL-Mansi *et al* (2000), Ismail (2002), Youssef (2007), Gue *et al*. (2012) and Hameda *et al*. (2012) all working on pea and Rugheim and Abdelgani (2012) on faba bean. These results could be attributed to the significant effect and role of rhizobium and phosphorein in fixing N2 and transforming the fixed form of P and increasing the uptake of nitrogen and phosphorus which helps in increasing the minerals of seeds.

The combination between mineral and biofertilizer types significantly increased the concentration of N, P, K and crude protein in pea seeds in the two seasons (Table 7). These results were in harmony with those obtained by some research workers as Ismail (2002) and Youssef (2007).

Table7. Effect of biofertilizers, nitrogen and phosphorus minerals fertilizers and their combination on N, P and K content of pea seeds

Season	**2009 - 2010**				**2010 - 2011**			
Characters **Treatments**	N%	P%	K%	Total crude protein %	N%	P%	K%	Total crude protein %
Control	2.77	0.48	1.31	17.28	3.23	0.53	1.46	20.16
100% N+P	4.27	0.62	2.22	26.69	4.73	0.69	2.29	29.58
Rhizobium	3.13	0.55	1.34	19.58	3.68	0.60	1.50	23.00
Phosphorien	2.83	0.57	1.55	17.69	3.36	0.65	1.68	20.97
Rhizo. + 0% N	3.41	0.56	1.52	21.33	3.93	0.66	1.65	24.56
Rhizo. + 25% N	4.15	0.58	1.89	25.92	4.64	0.68	2.04	29.00
Rhizo. + 50% N	4.39	0.62	2.15	27.45	4.94	0.70	2.27	30.86
Rhizo. + 100 %N	4.58	0.62	2.13	28.61	5.13	0.71	2.29	32.03
Phosph.+ 0% P	3.51	0.64	2.03	21.95	4.05	0.74	2.16	25.28
Phosph. + 25% P	3.97	0.67	2.05	24.83	4.47	0.79	2.15	27.91
Phosph. + 50% P	4.06	0.73	2.30	25.34	4.58	0.83	2.34	28.61
Phosph. + 100% P	4.15	0.77	2.25	25.92	4.66	0.88	2.36	29.11
Rhizo.+ phosp.+ 0% N,P	3.59	0.69	2.20	22.41	4.12	0.79	2.30	25.75
Rhizo.+ phosp.+ 25% N,P	4.23	0.76	2.24	26.44	4.74	0.88	2.33	29.59
Rhizo.+ phosp.+ 50% N,P	4.54	0.80	2.42	28.34	5.04	0.91	2.53	31.47
Rhizo.+ phosp.+ 100% N,P	4.74	0.83	2.39	29.61	5.24	0.91	2.52	32.77
L.S.D at 0.05	0.23	0.045	0.15	1.47	0.21	0.014	0.14	1.29

References

Ali, M. M. M. (2000). Effect of some agriculutural treatments on yield productivity of pea. M.Sc. Thesis, Fac. Agric., Moshtohor, Zagazig Univ.Benha Branch.

Ali, A., M. Ishtiaq and N.E. Jan (2003). Effect of Rhizobium leguminosarum inoculum on the growth and yield of different pea cultivars. Sarhad J. Agric. 19 (1): 55 – 59.

A.O.A.C., (1970). Official Methods of Analysis. The Association of Official Agricultural Chemists. Washington D. C.

Arumugam, R., **S. Rajasekaran and S. M. Nagarajan (2010).** Response of arbuscular mycorrhizal fungi and rhizobium inoculation on growth and chlorophyll content of *Vigna unguiculata* (L) Walp Var. Pusa 151. J. Appl. Sci. Environ. Manage., 14 (4): 113 – 115.

Banerjee, A. (2010). Importance of Use of biofertilizers. http://www.insdergreen.com /importance.biofertilizers/.

Bidwell, R. G. S. (1979). Plant Physiology. Second Edition. Macmillan Publishing Co., NewYork, NY.

Bieleski, R. L. (1973). Phosphate pools, phosphate transport and phosphate availability. Ann. Rev. Plant Physiol., 24: 225 – 252.

Brown, J. and O. Lilliland. (1946). Rapid determination of potassium and sodium in plant material and soil extracts by flame photometer. Proc. Amer. Soc. Hort. Sci., 48: 341- 346.

Dawa, K., E.A.A. Tartoura and M.A. Darweesh (2003). Effect of phosphorous fertilization and some growth promoters on growth and yield of pea (*pisum sativum L.*).J. Agric.Sci. Mansoura. Univ., 28 (2): 1327 – 1343.

Dhillon, S. S. (1978). Influence of varied phosphorus supply on growth and xylem sap cytokinin level of sycamore (*Platanus occidentalis L*.) seedlings. Plant Physiol., 61: 521 – 524.

Edmond, J. B., T. L. Senn, F. S. Znderws and R. G. Halfacre (1981). Fundamentals of Horticulture, Published by Tata Mc Graw–Hill Publishing Co., Limited, Indian.

El-Assiouty, F. M. M., and S. A. Abo-Sedera (2005). Effect of bio and chemical fertilizers on seed production and quality of spinach (*Spinacia oleracea* L.) Inter. J. Agric. & Biol., 7(6): 947 – 952.

EL-Gizawy, N. Kh. B. and S.A.S. Mehasen (2009). Response of Faba Bean to bio,mineral phosphorus fertilizers and foliar application with zinc. World Appl Sci J., 6 (10): 1359 – 1365.

Elkhatib, H.A. (2009). Growth and yield of commen BEAN (*Phaseolus vulgaris L.*) in response to Rhizobium inoculation, Nitrogen and Molybdenum fertilization. Alex Sci Exchange, 30 (2): 319 - 331.

Elkhatib, H.M., S.M. Gabr and A.M. EL-Keriawy (2007). Mathematical aspects of seed production response of pea (*Pisum sativum L*.) to Nitrogen and bio- fertilization. J. Agric.& Env. Sci. Alex. Univ., Egypt vol.6 (2): 218: 237.

Elkhatib, H. A., S. M. Gaber, F. I. Radwan and Abo R. F. EL-Ali (2009). Differential effects of mycorrhizal fungi and phosphate solubilizing bacteria and their potential for stimulating plant growth and seed yield of common bean. Alex. Sci. Exchange J., 30 (1): 136 – 145.

EL-Mansi, A. A., A. Bardisi and S. A. EL-Atabany (2000). Effect of Rhizobium inoculum and soil plastic mulch on nodulation, plant growth and yield of pea under sandy soil conditions. Zagazig J. Agric. Res., 27 (4): 899–912.

El-Shamma, H. A. (2000). Effect of chemical and biofertilizers on growth, seed and quality of new cv. of dry bean . Annals of Agric. Sci., Moshtohor. 38 (1): 461 – 478.

Fatima, Z., M. Zia and M. F. Chaudhary (2007). Interactive effect of rhizobium strains and Pon soybean yield, nitrogen fixation and soil fertility. Pak. J. Bot., 39 (1): 255 – 264.

Fatma, A. Abdo (2003). Effect of biofertilizer with phosphate dissolving bacteria under different levels of phosphorus fertilization on Mungbean plant. Zagazig J. Agric. Res., 30 (1): 187 – 211.

Gabr, S.M. and H.A.Elkeriaw (2007). Effect of different biofertilizer types and nitrogen fertilizer levels on growth, yield and chemical contents of pea plants (*Pisum sativum* L.). J. Agric.& Env. Sci. Alex. Univ., Egypt, 6 (2): 192 – 215.

Gabr, S. M., I. M. Ghoneim and H. M. Hassan (2001). Effect of bio- and nitrogen fertilization on growth, flowering, chemical contents, yield and quality of sweet pepper. J. Adv. Agric. Res. 6(4): 939 – 955.

Geneva, M., G. Zehirov, E. Djonova, N. Kaloyanova, G. Georgien and I. Stancheva (2006). The effect of inoculation of pea plants with mycorrhizal fungi and Rhizobium on nitrogen and phosphorus assimilation. Plant Soil Environ. 52 (10): 435 – 440.

Gomez, K.A. and A.A. Gomez. (1984). Statistical Procedures for Agricultural Research 2th edition. John Wiley and Sons, publication, New York, USA**.**

Gue, L., G. Chen, X. Sui, S. Zhang, Y. Yang, J. Long, Y. Hu and Z. Zeng (2012). Effects of inoculation with different *Rhizobium leguminosorum* strains on growth performances, yield and grain quality of a semi-leafless pea variety (chinese). J. of China Agric. Univ. 17 (1): 46 – 52.

Hamed, M. F. (2003). Faba bean productivity as affected by zink, phosphorus fertilizer and phosphorein. Ann. Agric. Sci., Moshtohor. 41 (3): 1047 – 1056.

Hameda. EL-S. E. A., EL-Sh. A. Amen, A. H. EL-Morsy and M. H. Tolba (2012). Effects of foliar spraying with microelements and different fertilizer sources on quality and yield of *Pisum sativum* L. plant. J. Agric. Sci. and soil Sci., 2 (1):17 – 24.

Haque, M. E. (2011). Effect of nitrogen and boron on the growth and yield of tomato (*Lycopersicon esculentum M.*). Inter. J. Bio-Resource & Stress management,. 2 (3): 277 – 282.

Hassan , M.N.M, M.M.,Farrag, S.H.Gad EL-Hak and R.H.M.Gheeth (1993). Effect of Rhizobium, Nitrogen and phosphorus application on growth and yield of peas. Fresh yield. Minia First Conference for Horticultural crops from 19 – 21 October, 1993.

Ismail,R.H.A. (2002). Physiological studies on biofertilization in pea plant (*Pisum sativum* L.) under calcareous conditions. Ph.D Thesis, Fac. Agric.,of Cairo Univ., Egypt, 407pp.

Jagnow, G., G. Hoflich and K. H. Haffmann. (1991). Inoculation of non-symbiotic rhizophere bacteria: Possibilities of increasing and stabilizing yields. Angew. Botanik. 65: 97 – 126.

Jitender, K. (2011). Effect of phosphorus and rhizobium inoculation on the growth, nodulation and yield garden pea (*Pisum sativum L.*) cv." Mattar Ageta-6". Legume Res.-An Inter. J.,. 34 (1): 20 – 25.

John, M. K. (1970). Colorimetric determination of phosphorus in soil and plant material with ascorbic acid. Soil Sci.,109: 214-220.

Kamel, A. S. M. (2006). Physiological studies on the production of sweet corn. M.Sc. Thesis, Fac. Agric., Al-Azhar Univ., Cairo.

Kanaujia, S. P., S. K. Sharma and N. Raj (2000). Effect of phosphorus, potassium and Rhizobium inoculation on mineral composition of pea (*Pisum sativum* L.).Hort. J., 13 (2): 51 – 55.

Krishna, KR and D. J. Bagyaraj (1984). Growth and nutrient uptake of peanut inoculated with mycorrhizal fungus Glomus fasciculatum compared with uninoculated ones. Plant and Soil, 17: 405-408.

Mahdi, S. S., G. I. Hassan, S. A. Rather, S. A. Dar and B. Zehra (2010). Bio-fertilizers in organic agriculture. J. Phyt. 2 (10): 42 – 54.

Mansour, N. T. S. (2000). Physiological studies on pea. M. Sc. Thesis, Fac. Agric., Moshtohor, Zagazig Univ.Benha Branch.

Martin P., A. Glatzle, W. Klob, H. Omay and W. Schmidt. (1989). N_2-fixing bacteria in rhizosphere: Quantification and hormonal effects on root development. Z. Pflanzenernuhr Bodenk. 152: 237 – 245.

Marschner, H. (1995). Mineral nutrition of higher plants (2nd edition). Academic Press, London.

Merghany, M.M. (1999). Response of Snap Bean to different Rhizobium inoculation methods and nitrogen levels under two drip irrigation regimes in new reclaimed sandy soil. Zagazig J. Agric. Res., 26 (4):1091 – 1123.

Metwally, A. M., A. A. El-Mansi, M. A. El-Beheidi, A. A. Guirgis and S. Swidan (1995). Effect of phosphorus and foliar spray with molybdenum on some morphological characters and yield of pea. Zagazig J. Agric. Res., 22 (6): 1463 – 1477.

Mishra, A., K. Prasad and R. Geeta (2010). Effect of Bio-fertilizer inoculations on growth and yield of dwarf field pea (*Pisum sativum L.*) in conjunction with different doses of chemical fertilizers. J. Agron. 9 (4): 163 – 168.

Mithen, S.(2003). After the Ice: A Global Human History 20,000-5,000 BC. Weidenfield and Nicholson, London.

Pregl, E. (1945). Quantitative organic micro analysis. 4th Ed. J. Chundril, London.

Rajasekaran, S., S. M. Nagarajan, K. Arumugam, R. Sravanamuthu and S. Balamurugan. (2006). Effect of dual inoculation (AM fungi and Rhizobium) on Chlorophyll content of Arachis hypogaea L. CV. TMV-2. Plant Archives, 6(2): 671-672.

Repka, J. (1979). Relationship between minerals nutrition, photosynthesis respiration and plant growth. Acta Fyatechmica, 35: 171 – 176.

Rugheim, A. M. E. and M. E. Abdelgani (2012). Effect of microbial and chemical fertilization on yield and seed quality of faba bean (*Vicia faba*). Inter. Food Res. J. 19 (2):417 – 422.

Sarg and M. H. Sawsan (2004). Influence of seed inoculation with phosphorein and levels of phosphorus fertilization on growth, mineral contents, seedless green pods yield and yield of seeds of three sugar pea cultivars under soil conditions. J. Agric. Sci. Mansoura Univ., 29 (8): 4729 – 4744.

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

Sherif. F. A., M. H. Hegazy and F. K. Abdel-Fattah (1997). Lentil yield and its components as affected by biofertilization and phosphorus application. J. Agric. Mansoura univ.22 (7): 2158 – 2194.

Yagodin, B. A. 1984. Agricultural Chemistry 2th ed., Mir., Moscow, Russia.

Yadav, R. P., D. V. S. Chauhan, and K. S. Yadav (1990). Effect of phosphorus, row spacing and irrigation on yield of pea. Ind. J. Agron., 35(3): 33 – 35.

Yifru abera, L. M. P. and H. Asfaw (2007). Effect of dual inoculation of rhizobium and phosphate-solubilising bacteria on nodulation, yield and N and P uptake of field pea (*Pisum sativum* L.). Ethiopian J. Natur. Reso.,.9 (2): 209- 230.

Youssef, A. Y. I. (2007). Physiological studies on pea nutrition and production. M.Sc. Thesis, Fac. Agric., Zagazig Univ., Egypt.

Zaman, S., M. Abdul Mazid and G. Kabir. (2011). Effect of rhizobium inoculation on nodulation, yield and yield traits of chickpea (*Cicer arietinum* L.) in four different soils of greater Rajshahi. J. Life Earth Sci., 6: 45-50.

Zhagloul, M. M., M. M. Darweesh, H. E. Abd El-Naby (1988). Effect of rhizobia inoculation and levels on growth and yield of pea plants. J. Agric. Sci., Mansoura Univ. Egypt.

تأثير التسميد الحيوى والمعدنى على نمو و إنتاجية البسلة

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أجريت هذه التجربة الحقلية خلال الموسم الشتوى لعامى ٢٠٠٩ / ٢٠١٠ و ٢٠١٠ / ٢٠١١ بمزرعة كلية الزراعة بمشتهر جامعة بنها – محافظة القليوبية بغرض دراسة تأثير مستويات التسميد المعدنى بعنصرى النيتروجين والفوسفور والتسميد الحيوى بكل من الريزوبيوم والفوسفورين كل على حدة والخلط بينهما مع الأسمدة المعدنية بالنيتروجين و الفوسفور و تأثير ذلك على النمو الخضرى و التركيب الكيماوى للمجموع الخضرى للنبات و كذلك أيضا محصول القرون الخضراء و مكوناته و محصول البذور الجافة من البسلة صنف ماستر بى. هذه المعاملات تم توزيعها فى قطاعات كاملة العشوائية فى أربع مكررات.

ولقد أظهرت النتائج أن التسميد بنسبة ١٠٠% أو ٥٠% من المعدل الموصى به من التسميد بالأسمدة المعدنية من النيتروجين والفوسفور كالتالى فى النيتروجين بمعدل (٤٠–٢٠كجم ن/فدان) و الفوسفور بمعدل (٣١–١٥,٥كجم فو٢أ٥/فدان) وتلقيح التقاوى قبل الزراعة بمخلوط الأسمدة الحيوية (الفوسفورين و الريزوبيوم) أعطى زيادة معنوية فى كل من طول الساق وعدد الأوراق وعدد الفروع لكل نبات و الوزن الطازج والجاف للمجموع الخضرى و كذلك أدى الى تأخير التزهير بشكل ملحوظ كما أدى ذلك الى أعلى تركيز لصبغات البناء الضوئى بالأوراق والنسبة المئوية لعناصر النيتروجين والفوسفور والبوتاسيوم والبروتين الخام فى المجموع الخضرى للنبات وكذلك أعطى أعلى القيم لعدد و وزن القرون الخضراء للنبات و محصول الفدان من القرون الخضراء كما أعطت هذه المعاملات زيادة فى كل من طول وقطر ووزن القرن وعدد و وزن البذور فى القرن ونسبة التصافى والوزن الجاف ل ١٠٠ من البذور و النسبة المئوية للنيتروجين و الفوسفور و البوتاسيوم و البروتين فى بذور البسلة ومحصول البذور الجافة للفدان ثم تلى تلك المعاملات المعاملة المحتوية على الأسمدة المعدنية من النيتروجين والفوسفور بنسبة ٢٥% مع الأسمدة الحيوية (الفوسفورين والريزوبيوم) ثم جاء بعد ذلك الريزوبيوم مع ١٠٠% تسميد نيتروجينى والريزوبيوم مع ٥٠% من التسميد النيتروجينى والفوسفورين مع ٢٥% فوسفور ثم الريزوبيوم مع ٢٥% نيتروجين ثم التسميد المعدنى من النيتروجين والفوسفور بالمعدل الموصى به ثم التسميد الحيوى بدون إضافات للأسمدة المعدنية وذلك بالمقارنة بالكنترول.