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Response of Pea Plant (*Pisum sativum* L.) for Levels of Nitrogen, *Rhizobium* Inoculation and Spraying of Molybdenum on Growth, Green Pods, Dry Seed Yield and its Components

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ABSTRACT

The current study was carried out at Qaha Vegetable Research Farm (Qalubia Governorate), Horticulture Research Institute, Agriculture Research Center (A. R. C.), Egypt, during the two consecutive winter seasons of 2014/2015 and 2015/2016 to study the influence of different nitrogen fertilization levels i.e. 20, 35 and 50 Kg N/ fed., an inoculation of pea seeds (*Pisum sativum* L.) cv. Master B with compatible strain of the nodule bacteria *Rhizobium leguminosarum*, foliar spraying with molybdenum twice at the rate of 10 Mg/ L. and its combinations on vegetative growth, total fresh green pod and dry seed yield (ton/ fed.). Increasing nitrogen fertilization levels from 20 to 50 Kg N/fed. alone led to significant increased plant pea growth, fresh green pod yield, green pod characters, dry seed yield, nitrogen, protein, phosphorus and potassium (%) presenting contents for dry seed. However, the earliest germination rate (days) were obtained with adding 35 Kg N/fed. during the two winter seasons, as compared with the other two levels (20 and 50 Kg N/fed.).Results showed that the *Rhizobium* inoculation gave better pea growth, green pods yield, dry seed yield and its quality as well as germination ratio, rate (days) and sprout length (cm) with adding 35 Kg N/fed. compared with the same treatments with other two N fertilization levels(20 and 50 kg N/fed). But the foliar spraying by molybdenum twice at the rate of 10 Mg/ L. led to significant increased with nitrogen level from 20 up to 50 Kg N/fed. for all traits under this study. On the other hand, adding 50 Kg N/fed. with the foliar spraying by molybdenum gave significant increased on all parameters for this study compared with other treatments. The results showed that adding 35 Kg N/fed. with *Rhizobium* inoculation and molybdenum foliar spraying twice at the rate of 10 Mg/L. led to significant increased for total green and dry pea seed yield as well as its characters compared with the same combination under other two nitrogen levels (20 and 50 kg N/fed). In generally, the combination between adding 35 kg N/fed, *Rhizobium* inoculation and molybdenum foliar spraying twice at the rate of 10 Mg/L was the highest economic return and led to provide 30% of nitrogen fertilization. Fedan = 4200 m^2**.**

Keywords: *Pisum sativum*, nitrogen levels, inoculation with *Rhizobium*, foliar, molybdenum.

INTRODUCTION

Pea (*Pisum sativum* L.) is one of the most important and popular legume vegetable crops grown in Egypt. Pea is a member of the family fabaceae. Field pea is primarily used for human consumption or as a livestock feed, has high levels of amino acids, lysine and tryptophan, which are relatively, low in cereal grains, it contains approximately 21-25 percent protein and high levels of carbohydrates, Blaine and Gregory (2009).

Concerning the necessary element of nitrogen, is a chlorophyll component it is promote vegetative growth and green coloration of foliage. It is also, directly involved in photosynthesis and is a necessary component of vitamins and aids in production and use of carbohydrates and influence energy reactions in plants (Sara *et al*., 2013). Nitrogen is the biologically combined with C, H, O and S to create amino acids, which are the building blocks of proteins. Amino acids are used in forming protoplasm, the site for cell division and thus for plant growth and development. Since all plant enzymes are made of proteins, nitrogen is needed for all of the enzymatic reactions in a plant. Nitrogen is a major part of the chlorophyll molecule and is therefore necessary for photosynthesis. Nitrogen is a necessary component of several vitamins and improves the quality and quantity of dry matter in leafy vegetables and protein in grain crops (Silva and Uchida, 2000).

As for N_2-fixing, which is an environment friendly biofertilizer may contribute to minimize the use of expensive chemical fertilizers. Pea like other legumes is capable of fixing and utilizing atmospheric nitrogen through symbiotic relationship with *Rhizobium* bacteria at the root of the crop. *Rhizobium* inoculants significantly improves yield in many leguminous crops. Use of nitrogen fixing rhizobia can play an important role in the life of host plant because it ensures their nitrogen supply, defense against pathogens, pests, adaptation to various environmental stresses, increase nitrogen uptake, play a crucial role as plant growth promoting Rhizobacteria in biofertilization system (Lodewyckx *et al*., 2002). Wagner (2011) pointed out that biological nitrogen fixation is one alternative to the use of nitrogen fertilizers. Its main advantages i.e. reduced cost of production, less groundwater pollution, enhanced protein production, more residual nitrogen for succeeding crops and increased soil fertility. Ngeno *et al*. (2012) suggested that application of 30 and 60 kg N/ ha. Alone or combination with inoculated with a commercial strain of *Rhizobium* of two garden pea cultivars significantly affected shoot biomass and dry matter the number of pods/ plant.

Respecting, molybdenum which is a constituent of the nitrogenase activity of plants, molybdenum has a positive effect on yield quantity, quality and nodule forming in legume crops (Anonymous, 2005). Molybdenum is a part of nitrate reductase, which is involved in reduction of NO_3 to NH_4 after its absorption by plants. Also, it is structural component of nitrogenase, which involved in nitrogen fixation of nitrogen into the ammonium form in a symbiotic relationship with legumes, Bhuiyan *et al*. (2008). In this respect, spraying molybdenum at 16 ppm resulted in maximum growth, nodule number and weight, nitrogenase activity, pod and seed yield as well as nutritional and chemical content of cowpea, Gad and Kandil (2013). Figueiredo *et al*. (2016) assumed that dose of nitrogen at planting, together with inoculation

with efficient *Rhizobium* spp. Strains and foliar fertilization with molybdenum at the rate of 0.2 g/L. can be important tools for increasing shoot dry weight, bean yields and profitability for farmers.

The main objectives of this investigation were to study the possibility of instead a part of the chemical nitrogen fertilization with a biofertilizer. Chemical fertilization cause humane hazard which is associate with environmental problems because of contamination by nitrogen leaching, volatilization and denitrification. Also, to study the influence of different three levels of nitrogen fertilization i.e. 20, 35 and 50 Kg N/ fed., an inoculation of pea seeds with compatible strain of the nodule bacteria *Rhizobium leguminosarum*, foliar spraying with molybdenum twice at the rate of 10 Mg/ L. as well as their combinations of all the possibility parameters in pea plants.

MATERIALS AND METHODS

This study was conducted during the two winter seasons of 2014/2015 and 2015/2016 at Qaha Vegetable Research Farm (Qalubia Governorate), Horticulture Research Institute, Agriculture Research Center (A. R. C.), Egypt. It was initiated to study the effect of nitrogen fertilization, inoculation bacteria *Rhizobium leguminosarum* and spraying by molybdenum on pea growth and yield. The soil type of this experimental field was clay loam. Soil samples were taken randomly of each year, before planting at the depth of 0 – 30 cm to determine the physical and chemical analysis of soil which determined according to Jackson (1973) as shown in Table (1).

Table 1. Physical and chemical analysis of soil before planting during the two winter seasons of 2014 and 2015.

Seasons	2014	2015
Soil texture	Clay	Clay
Clay %	51 %	50 %
Coarse sand %	14.2 %	14.0 %
Fine sand %	8.3 %	8.7 %
Silt %	26.5 %	27.3 %
Organic Matter %	1.51 %	1.44 %
pH	7.8	8.0
Electrical conductivity dS/m E.C. (mmhos/ cm)	2.2	2.3
Available N (ppm)	53.3	51.8
Available P (ppm)	4.2	3.9
Available K (ppm)	60.3	60.1

The experiment included 12 treatments as follow:

T1- 50 Kg N/ fed. (recommended dose) control.
T2- 50 Kg N/ fed. + *Rhizobium* inoculation.
T3- 50 Kg N/ fed. + spraying molybdenum.
T4- 50 Kg N/ fed. + *Rhizobium* inoculation + spraying molybdenum.
T5- 35 Kg N/ fed.
T6- 35 Kg N/ fed. + *Rhizobium* inoculation.
T7- 35 Kg N/ fed. + spraying molybdenum.
T8- 35 Kg N/ fed. + *Rhizobium* inoculation + spraying molybdenum.
T9- 20 Kg N/ fed.
T10- 20 Kg N/ fed. + *Rhizobium* inoculation.
T11- 20 Kg N/ fed. + spraying molybdenum.
T12- 20 Kg N/ fed. + *Rhizobium* inoculation + spraying molybdenum.

The treatments were arranged in a completely randomized complete block design with three replications.

Nitrogen was applied by hand in the form of ammonium sulphate $(NH_4)_2SO_4$ (20.6 % N). Pea seeds were inoculated with compatible strain of nodule bacteria *Rhizobium leguminosarum* was added as inoculated treatment at the rate of 200 g/fed. Bacteria was obtained from Biofertilization Production Unit; Soils, water and Environment Research, Institute; A. R. C., Giza, Egypt. Seeds were moistened in glue solution before application of inoculums to get a thin uniform coating of glue solution was used to ensure adhesion of the inoculants. After mixing, seeds were allowed to air-dry in the shade space for 15 minute to maintain the viability of cells and seed were air dried before sowing and sown within two hours. Spraying source of molybdenum is ammonium molybdate F. W. 1235.86 $[(NH_4)_6Mo_7O_{24}.4H_2O]$ contains 54 % of molybdenum.

Molybdenum foliar spraying was applied at twice achieved after 20 and 30 days from the sowing date intervals at the rate of 10 Mg/ L.

The experimental plot area was 10.8 m^2 and included 6 ridges each of 0.6 m width and 3 m length. Seeds of Master B were sown on the 1st week in November during the two winter seasons of 2014/2015 and 2015/2016, respectively in hills on one side of ridges at 10 cm apart. All required agricultural managements of pea's production such as irrigation, fertilization and pest control of studied area were followed according to the recommendations of Egyptian Ministry of Agriculture. The 2nd and 5th rows were used for fresh green character and green yield pods. The middle two rows (3rd and 4th) were used for dry total dry seed yield. Guard rows (1st and 6th) were set between the experimental units.

Data recorded:

1-Vegetative growth parameters:

A random sample of three plants from each experimental plot was taken at flowering and pod setting stages (55 days after sowing) to calculate plant heights (cm), number of leaves, fresh and dry weights of foliage per plant (g).

2-Total green pods yield (ton/ fed.) and pod characters:

At suitable maturity stage in the 2nd picking, random samples of ten green pods from each plot were taken to determine the following data i.e. average each of pod length and pod diameter (cm), green pod weight (g), number of green seeds/ green pod and green seeds weight/ green pod. Mature green pods were harvested at suitable maturity stage in tree picking and calculated as total green pods yield in (ton/ fed.).

3-Total dry seed yield (ton/ fed.) and its components:

A random samples of ten dry pods at the end of harvesting date (after the physiological mature) from each plot were taken to determine the following data i.e. average each of dry weight of pods (g), dry seed weight

/ dry pod (g), shell out % of dry pods, seed index (the dry weight of 100 seeds) and total dry seed yield (ton/fed.).

Shell out % of dry pods was calculated using the following equation:

$$\text{Shell out \%} = \frac{\text{Weight of dry seeds}}{\text{Weight of dry pods}} \times 100$$

4-Chemical composition of dry pea seeds:

Fresh weight of pea seeds was dried in an electric forced-air oven at 70 ^{o}C to constant weight then fractionated and sifting. The fine powder (at 0.2 g) of dry sample was digested in a mixture of sulphuric and perchloric acids according to **Piper (1947)** to estimate total nitrogen in seeds as wet digestion. Total nitrogen (%) was determined by using the modified "Micro-Kheldahl" method apparatus of Parnas and Wagner as described by **Pergl (1945)**. Protein % was calculated in seeds by multiplying nitrogen (%) content by 6.25. Phosphorus (%) was estimated in seeds spectrophotometrically using the chloraostannous reduced molybdophosphoric blue color method in sulphuric acid system as described by **King (1951)**.

5- Seed germination tests:

Three random samples (100 dry seeds each) were used from each treatment for calculating the following records; germination (%) and germination rate (days). Germination rate was calculated according to the following equation:

$$\text{Germination rate} = \frac{(G_1 \times N_1) + (G_2 \times N_2) + \ldots\ldots\ldots\ldots (G_n \times N_n)}{G_1 + G_2 + \ldots\ldots\ldots\ldots G_n} = \text{days}$$

Where, G = Number of germinated seeds in certain day, N = Number of this certain day. Sprout length (cm), 25 seeds were distributed on watered sheets of Whatman filtrated papers No.1 that had been thoroughly moistened with water and incubated at 25 ^{0}C for 14 day. Sprout length (cm) was taken after germination beginning for 2 day intervals until finishing the incubation period.

6-Economic study:

Economic analyses were performed based on the total net return, was calculated with the respect market price multiplying mean of the two seasons on total green pods yield (ton/ fed.) × Price of sell one ton of green pods – costs of treatments and workers/ one fed. (Egyptian Pound) = total net return with Egyptian Pound /fed.

7-Statistical analysis:

All data were subjected to the statistical analysis with MSTAT-C computer software package was used of variance and treatment means were compared according to the Least Significant Differences (L. S. D. 0.05 %) test method as described by Snedecor and Cochran (1980).

RESULTS AND DISCUSSION

1-Vegetative growth parameters:

Data presented in Table 2 show the effect of combinations between nitrogen fertilization, inculcation of bacteria *Rhizobium leguminosarum* and spraying by molybdenum on pea plant vegetative growth parameters. Data showed that significant increase on plant growth parameters i.e. plant height, number of leaves per plant as well as plant fresh and dry weight by adding the recommended dose (50 kg N/fed.) of N fertilizer compared with other two levels (35 and 20 kg N/fed). These results agreed with those reported by Marschner (1995) who reported that increase of vegetative growth characters due to the effect nitrogen on the internodes elongation by increasing the plasticity of cell wall through its effect on production of auxin formation in plant may be increased presumably due to the increase in tryptophan which is a precursor of indole acetic acid (IAA) as well as enhancement of meristematic cell division. Nitrogen is an essential element for building up protoplasm, amino acids and protein, in addition to its vital contribution in several biochemical processes that related to plant growth. In this respect, Gheeth *et al*. (2013) they proposed that adding 25, 50 and 75 Kg N/ fed. Of pea. Adjust the nitrogen fertilization as 75 followed with 50 kg N/ fed. Were the best rates for produce the tallest plant height and the highest number of branches/ plant. Figueiredo *et al*. (2016) decided that the application of 80 kg N /ha. Increased the mean values of the shoot dry weight in bean plants.

Table 2. Effect of nitrogen fertilization, *Rhizobium* inoculation, foliar spraying with molybdenum and its combinations on vegetative growth parameters of pea plants during the two winter seasons of 2014/2015 and 2015/2016.

Treatments	Plant height /plant(cm)		Number of leaves/plant		Fresh weight of foliage/plant		Dry weight of foliage/plant	
	1st Season	2nd Season	1st Season	2nd Season	1st Season	2nd Season	1st Season	2nd Season
50 Kg N/ fed.	69.3	66.0	27.3	25.7	35.58	31.50	5.50	4.77
50 Kg N/ fed.+ Inoculation	67.0	61.7	25.7	22.7	33.70	29.40	4.98	4.14
50 Kg N/ fed.+ spraying Mo	72.7	69.7	31.0	28.0	39.51	34.55	6.21	5.35
50 Kg N/ fed.+ Inoc.+ Mo.	63.7	58.5	23.7	21.0	31.84	28.19	5.16	3.69
35 Kg N/ fed.	62.0	59.3	24.0	19.7	31.51	26.17	4.85	3.77
35 Kg N/ fed.+ Inoculation	66.7	64.7	28.0	24.0	35.85	33.42	6.00	5.14
35 Kg N/ fed.+spraying Mo.	65.3	61.7	27.7	22.0	34.00	30.90	5.56	4.52
35 Kg N/ fed.+ Inoc.+ Mo.	68.00	66.7	29.3	26.3	38.17	34.68	6.27	5.29
20 Kg N/ fed.	54.3	51.7	19.7	17.7	25.22	21.60	3.91	3.18
20 Kg N/ fed.+ Inoculation	55.7	53.1	22.0	19.0	26.78	24.35	4.20	3.47
20 Kg N/ fed.+spraying Mo.	58.3	55.9	24.3	21.7	28.16	24.77	4.38	3.62
20 Kg N/ fed.+ Inoc. + Mo.	60.0	58.3	25.7	24.7	30.47	26.11	4.79	3.90
L.S.D. at 0.05%	2.7	2.2	3.2	2.3	3.1	2.2	0.57	0.46

Fed. = 4200 m^2.

Data presented in the same Table 2 obviously revealed that adding nitrogen fertilizer at dose of 35 Kg N/ fed. With the combination i.e. an inoculation with compatible strain of nodule bacteria *Rhizobium leguminosarum* plus topdressing of molybdenum, significantly increased the vegetative growth parameters of pea plants, i.e. plant height, number of branches, fresh and dry weights of foliage per plant followed by seed inoculation alone with the same strain of nodule bacteria as well as foliar spraying with molybdenum treatments as compression with the two other combinations and non-treated control plants.

It worth here to mention that, response pea plant to adding 35 Kg N/ fed. Plus the treatments of combination i.e. an inoculation with the same strain of nodule bacteria *Rhizobium leguminosarum* plus topdressing of molybdenum and an inoculation of pea seeds alone can be explained by the low contents of the concentrations of organic matter and main mineral elements, as mention before in the chemical analysis of soil in Table (1).

Data in the same Table 2 regarding to pea seeds were inoculation alone with the same strain of nodule bacteria and received the lowest nitrogen fertilizer level (20 Kg N/fed.) obtained significant increase only in the fresh weight of foliage/ plant in the 2nd season as compared with un-inoculated plants.

The results also, showed that the addition of N recommended dose (50 kg N/fed.) with spraying molybdenum foliar gave significant increased on all vegetative growth parameters adding. This may be attributed to the favorable effect of molybdenum as a plant nutrient is related to its function as a metal component of some enzymes that catalyze nitrogen fixation, nitrate assimilation and reduction also, molybdenum improved root and shoot biomass in pea plants (Hristozkova *et al*., 2006).

Regarding the positive effect of the combination i.e. an inoculation of pea seeds with compatible strain of nodule bacteria *Rhizobium leguminosarum* plus foliar spraying with molybdenum as well as inoculation alone with nodule bacteria only, the obtained results are in a good accordance with those recorded by (Brkić *et al*., 2004) they declared that seed inoculation with a bio-preparation of nodule bacteria *Rhizobium leguminosarum*, fertilization up to 40 kg N/ha. And spraying molybdenum achieved significant differences increased in the dry mater on pea plants. With respect to an inoculation with the nodule bacteria, our results are in a good line with those of Talebipour *et al.* (2015) they reported that inoculation of *Rhizobium phaseoli* strains significantly enhanced the plant height over the control on common bean. Zaghloul *et al.* (2015) referred that the highest significant values of nitrogenase activity and all estimated pea vegetative growth were observed in nodules formed in plants inoculated with biofertilizers contain three bacterial strains namely *Rhizobium leguminosarum* bv. *Vicieae*, *Glomas bagyarajii* and *Bacillus circulans*.

Concerning the favorable effects of spraying molybdenum as foliar application, the results further proved by Gad and Kandil (2013) they suggested that the highest growth parameters such as plant height, root length, number of branches and leaves of cowpea, were obtained from spraying molybdenum at the rate of 16 ppm and adding 100 % nitrogen fertilization compared with the control. Figueiredo *et al*. (2016) commented that foliar application of molybdenum at the rate of 0.2 g/L. increased the mean value of the shoot dry weight in bean plants.

On the contrary, inoculation of pea seeds and fertilized with the highest dose of nitrogen fertilizer level (50 Kg N/fed.) obtained negative results on the vegetative growth parameters, may be due to the higher doses of mineral nitrogen resulted in nodule mass reduction especially with foliar spraying of molybdenum treatment, this result can be explained why molybdenum treated legumes decreased in nodule number compared to the untreated plants, which plants uptake a higher amount of nitrogen element as shown in Table (5). Concerning the reduction in the vegetative growth in the same Table 2 with an inoculation of pea seeds and the combination of an inoculation of pea seeds and foliar spraying with molybdenum at the highest level of nitrogen fertilizer, similar results were also, reported by (Brkić *et al*., 2004) they generalized that seed inoculation with a bio-preparation of nodule bacteria *Rhizobium leguminosarum*, fertilization up to 80 kg N/ha. And spraying molybdenum achieved non significant difference increased in the dry mater on pea plants. Achakzai (2007) pointed out that number of nodules, nodules fresh and dry weights were significantly and linearly decreased as nitrogen levels progressively increased only up to 100 Kg N/ha. In pea cultivars. Also, Abdel-Aziz and Salem (2013) working on cowpea. Furthermore, Zaghloul *et al.* (2015) declared that adding nitrogen as chemical fertilizers at the rate of 40 kg N as ammoniums sulfate/fed. Plus inoculation of pea seeds gave the lowest records of all estimated pea vegetative growth i.e., plant height, number of branches per plant and dry weight of stem.

2-Total green pod yield (ton/ fed.) and pod characters:

Data in Table (3) showed that the effect of combinations between nitrogen fertilization, inculcation of bacteria *Rhizobium leguminosarum* and spraying by molybdenum on green pod yield (ton/ fed.) and some pod characters.

Data clearly indicated that, the increase in the nitrogen fertilization rat led to significant increase in green pods yield and some pods qualities. These results are supported by findings of other researchers like, Gheeth *et al*. (2013) decided that the rate of 50 followed with 75 kg N/ fed. Was the best rate for gave the highest total green pods yield as well as yield characters i.e. pod weight, length diameter, number of seeds per pod and weight of seeds per pod, dry pods, dry seed yield (ton/ fed.) and average weight of 1000 seeds.

Regarding the effect of an inoculation with nodule bacteria and foliar spraying with molybdenum and its combinations treatments of pea plants fertilized with two nitrogen fertilization levels i.e. 35 and 20 Kg N/fed. Data presented in the same Table and Chart (1) obviously revealed that resulted of the combinations

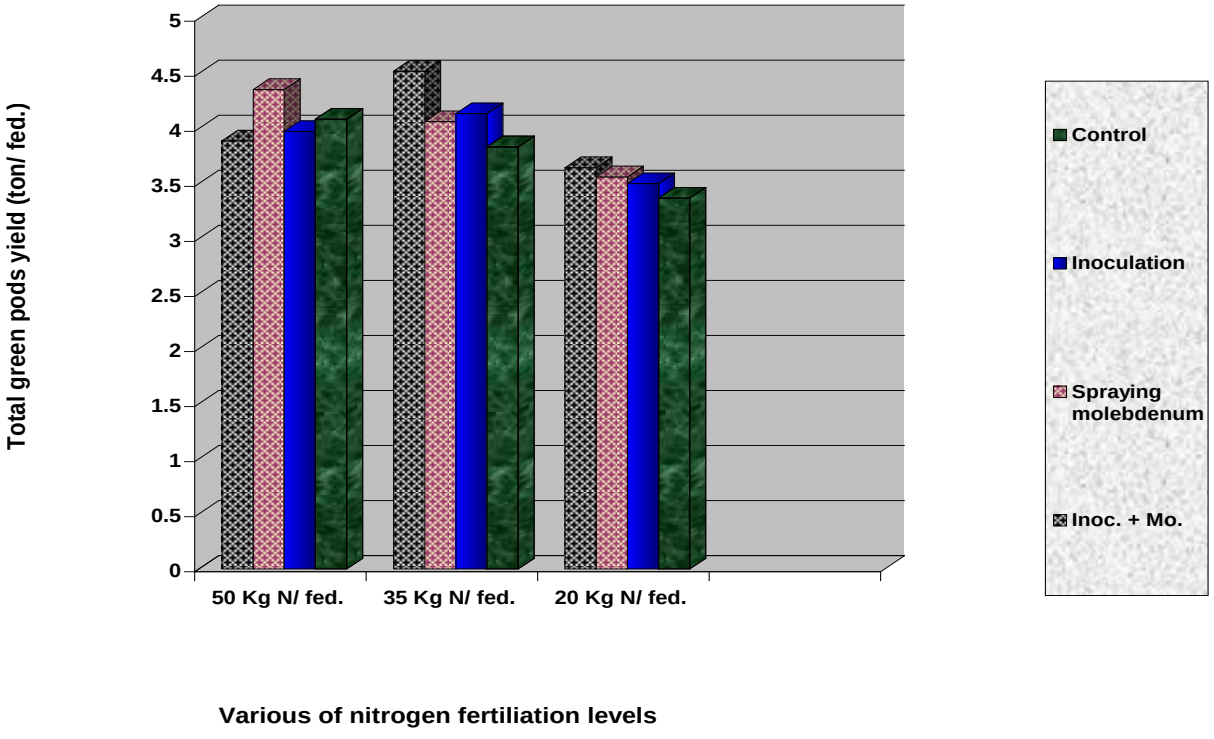
between N fertilization, *Rhizobium* inoculation spraying of molybdenum significantly increased the total green pods as well as its traits compared with other treatments under the same two N fertilization levels.

Table 3. Effect of nitrogen fertilization, *Rhizobium* inoculation, foliar spraying with molybdenum and its combinations on total green pod yield (ton/fed.) and pod parameters of pea plants during the two winter seasons of 2014/2015 and 2015/2016.

Treatments	Average Pod length (cm)		Average Pod diameter (cm)		Average green pod weight (g)		Average No. of green seeds/pod		Average green seed weight (g)/green pod		Total green pod yield (ton/ fed.)	
	1st Season	2nd Season	1st Season	2nd Season	1st Season	2nd Season	1st Season	2nd Season	1st Season	2nd Season	1st Season	2nd Season
50 Kg N/ fed.	9.38	8.81	0.98	0.92	5.69	5.33	7.9	7.7	2.90	2.65	4.253	3.918
50 Kg N/fed.+ Inoculation	9.11	8.47	0.95	0.89	5.34	4.95	7.6	7.3	2.69	2.39	4.188	3.761
50KgN/fed.+ spraying Mo	9.96	9.36	1.11	0.96	6.36	5.89	8.1	8.0	3.31	2.99	4.536	4.173
50 Kg N/fed.+ Inoc.+ Mo.	8.78	8.31	0.91	0.86	5.45	4.91	7.5	7.2	2.67	2.34	4.048	3.728
35 Kg N/ fed.	9.07	8.00	0.96	0.91	5.19	5.06	7.4	7.2	2.65	2.42	3.998	3.670
35 Kg N/fed.+ Inoculation	9.54	8.48	1.00	0.94	5.61	5.53	7.8	7.5	2.95	2.74	4.380	3.891
35KgN/fed.+spraying Mo.	9.51	8.60	0.97	0.91	5.48	5.42	7.7	7.3	2.81	2.65	4.321	3.806
35Kg N/fed.+ Inoc..+ Mo.	9.88	9.11	1.16	1.04	5.94	5.83	8.2	7.7	3.19	3.12	4.737	4.306
20 Kg N/ fed.	8.67	7.78	0.92	0.83	4.85	4.78	7.2	6.8	2.35	2.29	3.595	3.143
20 Kg N/fed.+ Inoculation	9.08	7.90	0.96	0.86	5.20	5.19	7.4	7.1	2.54	2.44	3.742	3.259
20KgN/fed.+spraying Mo.	9.21	8.14	0.95	0.88	5.32	5.23	7.5	7.2	2.61	2.47	3.788	3.336
20 Kg N/ fed.+Inoc.+ Mo.	9.28	8.40	0.97	0.89	5.58	5.29	7.6	7.4	2.79	2.62	3.907	3.384
L.S.D. at 0.05%	0.37	0.29	0.05	0.04	0.38	0.31	0.30	0.24	0.17	0.13	0.169	0.113

Fed. = 4200 m^2.

Chart (1): Adding various three levels of nitrogen fertilizer, inoculation, foliar spraying with molybdenum and their combinations of mean total green pods weight (ton/ fed.) of pea plants during the two winter seasons of 2014/2015 - 2015/2016



Concerning the effect of spraying molybdenum as foliar application which caused a positive effect on the most of total green pods and as well as its terms. This increment in total yield may be owe directly to the increment of vegetative growth parameter i.e. plant height, number of both branches and leaves/ plant, dry weight of foliage/ plant and the increment in enzymes activity, with the exception of number of green seeds/ pod in the 1st season only with 50 kg N/fed. Level and pod diameter in the two seasons.

For the aim of this study it's to decrease the use of chemical N fertilization, the results showed that the best treatment for safety yield is combination between 35 kg N/fed. With nodule bacteria inoculation and foliar spraying by molybdenum.

These results was supported by (Brkić *et al*., 2004) they claimed that seed inoculation with a bio-preparation of nodule bacteria *Rhizobium leguminosarum*, fertilization up to 40 kg N/ha. And spraying molybdenum obtained significant differences in the yield, dry seed, average number of pods per plant and average number of seeds per pod per plant on pea plants. Rajib *et al*. (2015) commented that inoculation seed of garden pea with *Rhizobium* alone or comprised with adding molybdenum at the rate of 0.5 Kg/ ha. Obtained significant increases in pod length, pod weight, number of seeds per pod, shelling percentage, 100 seed weight and green pod yield ton/ha.

Various results concerning the inoculation of *Rhizobium* affecting the 2nd and the 1st fertilizer level strongly confirm by those finding about inoculation of *Rhizobium* by Ahmed *et al.* (2007) assumed that performed best in regarding the number of pods/plant, number of seeds/ pod, 1000 – seed weight, highest green pod yield, green seed yield, mature pod yield and mature seed yield were obtained by co-inoculation of seed and soil with *Rhizobium* strain over uninoculated control on pea. Talebipour *et al.* (2015) commented that inoculated with different *Rhizobium phaseoli* strains was significant for pod yield, seed yield, 100-seed weight and biological yield on common bean.

The simulative effects of induced by molybdenum foliar application on most of the parameters studied of total green pods and dry seed yield (ton/ fed.) as well as its terms, were similar to that obtained by Gad and Kandil (2013) exhibit that spraying molybdenum at 16 ppm had a significant increased on number and weight of pods /plant, weight of seeds/ plant and total pods yield on cowpea.

Moreover, Talebipour *et al.* (2015) referred that foliar application of molybdenum at the rate of 1.5 g /L. gave the best benefit to increase the pod yield, seed yield and pod number per plant on common bean. Figueiredo *et al*. (2016) suggested that foliar application of molybdenum at the rate of 0.2 g/L. Mo. Increased the in bean yield.

3- Total dry seed yield (ton/fed.)and its components:

Data in Table (4) show the effect of some levels of N fertilization and its combination with *Rhizobium* inoculation and foliar spraying of molybdenum on dry seed of peas and its component. The results showed that the increase of nitrogen fertilization from 20 to 50 kg N/fed. Alone led to significant increase in dry seed yield and its components. On the other hand, the results in Table 4 showed that the relationship between the rate of nitrogen fertilization and molybdenum foliar spraying for dry seed yield and its components have been better with adding 50 Kg N/fed. Compared with the other two levels on dry seed

Table 4. Effect of nitrogen fertilization, *Rhizobium* inoculation and foliar spraying with molybdenum and its combinations on total dry seed yield (ton/fed.) of pea and its components during the two winter seasons of 2014/2015 and 2015/2016.

Treatments	Average weight of dry pods (g)		Average dry seed weight / dry pod (g)		Average Shell out % of dry pods		Average 100 dry seed weight (g)		Total dry seed yield (Ton/fed.)	
	1st Season	2nd Season	1st Season	2nd Season	1st Season	2nd Season	1st Season	2nd Season	1st Season	2nd Season
50 Kg N/ fed.	1.24	1.07	0.939	0.793	75.7	74.1	15.32	14.88	1.139	0.966
50 KgN/fed.+ Inoculation	1.18	1.03	0.892	0.759	75.5	73.7	14.79	14.15	1.090	0.906
50 KgN/fed.+spraying Mo.	1.31	1.16	1.010	0.878	77.1	75.7	15.65	15.47	1.237	1.093
50 Kg N/fed.+ Inoc.+ Mo.	1.15	0.99	0.862	0.728	74.9	73.5	14.49	14.20	1.048	0.899
35 Kg N/ fed.	1.11	0.93	0.828	0.683	74.6	73.4	15.11	14.51	1.126	0.938
35 KgN/fed.+ Inoculation	1.23	1.06	0.938	0.800	76.3	75.5	15.71	15.32	1.216	1.000
35KgN/fed.+spraying Mo.	1.16	1.04	0.880	0.777	75.8	74.7	15.38	15.14	1.172	0.974
35 Kg N/ fed.+ Inoc.+ Mo.	1.39	1.19	1.094	0.907	78.7	76.2	16.77	15.86	1.329	1.079
20 Kg N/ fed.	1.00	0.84	0.736	0.610	73.6	72.6	14.27	13.18	0.933	0.769
20 Kg N/ fed.+ Inoculation	1.05	0.89	0.785	0.648	74.7	72.8	14.59	13.38	0.945	0.799
20 KgN/fed.+spraying Mo.	1.09	0.91	0.815	0.668	74.8	73.4	14.74	13.91	1.020	0.832
20 Kg N/ fed.+ Inoc. + Mo.	1.13	0.98	0.855	0.723	75.7	73.8	15.13	14.31	1.049	0.875
L.S.D. at 0.05%	0.05	0.04	0.047	0.039	1.2	1.0	0.61	0.54	0.071	0.058

Fed. = 4200 m^2.

Yield (ton/ fed.) and its terms. The previous findings coincided with those obtained by Abdel-Aziz and Salem (2013) indicated that the context results obtained with individual seed microbial inoculated with

Azospirillum sp. And *Trichoderma* sp. On total dry seed yield (ton/ fed.) and pod characters of cowpea at the highest level of adding nitrogen (100 % recommended dose) i.e. 61.8 N pure Kg/ fed. As compared to the other two fertilization levels and the control treatment. Zaghloul *et al.* (2015) declared that adding nitrogen as chemical fertilizers at the rate of 40 kg N as ammonium sulfate/fed. The combination with biofertilizers gave the lowest records of all estimated pea yield parameters i.e. number of the pods/plant, weight of pod (g), number of seed/pod and dry weight of 100 seed (g). The results in the same Table showed that the combination of bacterial inoculation and foliar spraying of molybdenum with adding 35 kg N/fed. Have led to a significant increase in the yield of dry seeds and its components compared to other treatments under the other two levels.

The results indicated that the fertilization at rate of 35 kg N/fed. With *Rhizobium* inoculation and foliar spraying of molybdenum is the best to achieve the aim of the study; it has led to high and relatively safe production of peas seed. Similar finding were obtained by Brkie *et al.*, 2004 on pea and Abdel – Aziz and Salem, 2013 on cowpea**.**

4-Chemical composition of dry pea seeds:

With regard to the effect of nitrogen fertilizer on nitrogen, protein, phosphorus and potassium (%) contents during the two winter seasons, illustrated in Table (5) clearly deciphered that, all nitrogen fertilizer doses significantly increased nitrogen, protein, phosphorus and potassium (%) contents in dry pea seeds. These results are in agreement with results reported by Gheeth *et al*. (2013) recorded that nitrogen fertilization as 75 followed with 50 kg N/ fed. Were the best rate for pea seed content of nitrogen and protein (%) as compared to the other rates.

Data presented in the same Table obviously revealed that the favorable effects of the all treatments significant differences on nitrogen, protein, phosphorus and potassium (%) contents in dry pea seeds. The best treatment was the combination between an inoculation of pea seeds with the same nodule bacteria and foliar spraying with molybdenum as affected fertilized with 35 Kg N/fed. It worth here to mention that foliar application of molybdenum was the best treatment causes an increment in the chemical composition specially nitrogen and subsequent increase protein (%) content of dry pea seeds, because of its involvement in the nitrate assimilation, nitrogen fixation processes and transport of nitrogen compounds in plants, molybdenum plays a crucial role in nitrogen metabolism of plants (Li *et al*., 2013).

Table 5. Effect of nitrogen fertilization, *Rhizobium* inoculation, foliar spraying with molybdenum and its combinations on some macronutrients and protein (%) contain of dry pea seeds during the two winter seasons of 2014/2015 and 2015/2016.

Treatments	Nitrogen (%)		Protein (%)		Potassium (%)		Phosphorus (%)	
	1st Season	2nd Season	1st Season	2nd Season	1st Season	2nd Season	1st Season	2nd Season
50 Kg N/ fed.	4.246	4.082	26.54	25.51	0.761	0.697	0.832	0.752
50 Kg N/ fed.+ Inoculation	4.203	3.912	26.27	24.45	0.748	0.690	0.809	0.749
50KgN/ fed.+ spraying Mo	4.766	4.540	29.79	28.38	0.805	0.719	0.877	0.821
50 Kg N/ fed.+ Inoc.+ Mo.	4.037	3.866	25.23	24.16	0.717	0.663	0.789	0.729
35 Kg N/ fed.	3.984	3.781	24.9	23.63	0.748	0.683	0.766	0.705
35 Kg N/ fed.+ Inoculation	4.424	3.940	27.65	24.63	0.792	0.728	0.811	0.740
35 KgN/fed.+spraying Mo.	4.186	3.911	26.16	24.44	0.782	0.712	0.791	0.715
35 Kg N/ fed.+ Inoc.+ Mo.	4.645	4.450	29.03	27.81	0.820	0.787	0.828	0.799
20 Kg N/ fed.	3.809	3.464	23.81	21.65	0.705	0.603	0.690	0.615
20 Kg N/ fed.+ Inoculation	4.092	3.664	25.58	22.90	0.719	0.642	0.704	0.648
20 KgN/fed.+spraying Mo.	4.108	3.736	25.68	23.35	0.733	0.681	0.746	0.695
20 KgN/ fed.+ Inoc. + Mo.	4.129	3.8245	25.81	23.90	0.780	0.705	0.769	0.745
L.S.D. at 0.05	0.090	0.077	0.50	0.38	0.026	0.018	0.028	0.021

Fed. = 4200 m^2.

As for the enhancing effects of the combination treatments, the previous results are in line with those obtained by (Brkić *et al*., 2004) they pointed out that seed inoculation with a bio-preparation of nodule bacteria *Rhizobium leguminosarum*, fertilization up to 40 kg N/ha. And spraying molybdenum increased seed protein concentration. In respect of, the positive effects of inoculation alone of pea seeds on chemical composition of dry pea seeds as effective the 2nd and the 1st level of nitrogen fertilizer. These finding are close conformity to findings with Ahmed *et al.* (2007) assumed that plant receiving seed and soil *Rhizobium* inoculation recorded the highest protein contents both in green and mature seeds of pea. Tahir *et al.* (2009) on soybean indicated that *Rhizobium* strain of *Bradyrhizobium japonicum* inoculation alone significantly increased soybean seed nitrogen, protein and phosphorus (%) over uninoculated control due to *Rhizobium* inoculation was mainly due to significant increased in nodulation, resulted in higher accumulation of nitrogen due to atmospheric N_2-fixation also, higher phosphorus uptake due to *Rhizobium* inoculation was due to the ability of applied rhizobia to solubilize precipitated phosphorus components thereby increased phosphorus uptake in plants. El-Sayed *et al*. (2012) recorded that seeds inoculation with nitrogen fixing bacteria (*Rhizobium leguminosarum*) significantly increased total protein % content in pea seeds. In this

respect, the positive stimulatory effects of using nodule bacteria might be due to that using biofertilizer which is a natural product carrying living microorganisms derived from the root or cultivated soil. So they don't have any ill effect on soil health and environment. Besides their role in atmospheric nitrogen fixation and phosphorous solubilisation, these also, help in stimulating the plant growth hormones providing better nutrient uptake (Anandaraj and Tech, 2010).

Respecting the stimulate effects of molybdenum, those perverse results corresponds to the results reported by Gad and Kandil (2013) declared that spraying molybdenum at the rate of 16 ppm significantly increased the content of N, P and K and protein contain (%) in cowpea seeds compared with the untreated plants. Figueiredo *et al*. (2016) recorded that foliar application of molybdenum at the rate of 0.2 g/L. increased the mean value of the shoot nitrogen accumulation in bean plants.

In the context, an inoculation of pea seeds plus foliar spraying with molybdenum as affected fertilized with the highest dose of nitrogen fertilizer (50 kg N/fed.) obtained negative results especially with foliar spraying of molybdenum on chemical composition of dry pea seeds, the previous findings coincided with those obtained by Abdel-Aziz and Salem (2013) advocated that the contrary results obtained with seed microbial inoculated with *Azospirillum* sp. And *Trichoderma* sp. With the highest level of adding nitrogen (100 % recommended dose) i.e. 61.8 N pure Kg/ fed. Seeds of cowpea decreased nitrogen, phosphorus and potassium and protein (%) contain as compared with the third level (75 % recommended dose) i.e. 46.4 N pure Kg/ fed. Zaghloul *et al.* (2015) declared that adding nitrogen as chemical fertilizers at the rate of 40 kg N_2 as ammonium sulfate/fed. Gave the lowest records of total nitrogen, phosphorus and potassium were observed in soil treated with chemical fertilizers plus inoculated with biofertilizers of pea plants.

5- Germination tests of dry pea seeds:

With regard to the germination tests (Table 6), germination is a technologic application widely used for its ability to decrease levels of antinutritional factors present in legume seeds and improve the concentration and availability of their nutrients (Vidal *et al*., 2002). Concerning the germination tests of pea seeds as

Table 6. Effect of nitrogen fertilization, *Rhizobium* inoculation, foliar spraying with molybdenum and its combinations on germination tests of dry pea seeds during the two winter seasons of 2014/2015 and 2015/2016.

Treatments	Germination ratio (%)		Germination rate (days)		Sprout length (cm)	
	1st Season	2nd Season	1st Season	2nd Season	1st Season	2nd Season
50 Kg N/ fed.	88	80	2.90	2.84	39.3	36.6
50KgN/fed.+ Inoculation	90	80	2.94	2.88	38.8	35.0
50KgN/fed.+spraying Mo.	96	90	2.85	2.73	41.5	38.6
50 Kg N/ fed.+ Inoc.+ Mo.	88	82	2.92	2.88	40.0	36.0
35 Kg N/ fed.	92	84	2.74	2.67	37.3	35.4
35 Kg N/ fed.+ Inoculation	96	88	2.66	2.64	41.2	37.3
35 Kg N/ fed.+spraying Mo.	96	90	2.67	2.60	38.0	36.7
35 Kg N/ fed.+ Inoc.+ Mo.	98	92	2.59	2.55	41.1	39.7
20 Kg N/ fed.	90	82	2.82	2.78	34.0	32.2
20 Kg N/ fed.+ Inoculation	92	84	2.78	2.75	34.8	33.8
20 Kg N/ fed.+spraying Mo.	94	84	2.75	2.71	36.1	33.3
20 Kg N/ fed.+ Inoc. + Mo.	94	86	2.72	2.63	36.9	34.7
L.S.D. at 0.05	2.4	2.1	0.07	0.05	1.09	0.98

Fed. = 4200 m^2.

Affect nitrogen fertilizer levels (Table 6), germination ratio showed non-significant for varying three fertilizer levels when adding alone. The earliest germination rate (days) were obtained at nitrogen fertilization at the 2nd rate of 35 kg N/ fed. As compared with the rest of the two levels. Whereas, increasing nitrogen from 20 to 50 kg N/ fed. Significant increasing in the sprout length (cm).

As for, the effect of various treatments illustrated in Table (6) clearly deciphered that, the best results of the previous treatments were the combinations that involved seed inoculation and molybdenum foliar application affected nitrogen fertilization at the 2nd rate of 35 kg N/ fed. Significantly surpassed on the other treatments.

6-Economic study:

Data presented in the Table (7) represented that the net income per fed. Of different treatments indicated that treating seed of pea plants with the combination of *Rhizobium* inoculation and foliar spraying with molybdenum and adding the 2nd rate of 35 kg N/ fed. Obtained the highest profitability for farmers, inoculation of pea seeds with *Rhizobium* alone in the same level followed with molybdenum foliar application and adding the 3rd rate of 50 kg N/ fed. As compared the control un-treated treatments.

Table 7. Effect of some treatments on net income/ fed. On average total green pods yield (ton/ fed.) pea plants during the two winter seasons of 2014/2015 and 2015/2016.

Treatments	Average total green pods yield (ton/ fed.)	Total income with Egyptian pound before spraying (Total yield × price)	Costs of treatments and workers/ one fed. (E. P.)	Net income after cost of treatments and workers without cost of agriculture practices	Ranking treatments
50 Kg N/ fed.	4.086	9194	0.00	9194	3
50 Kg N/ fed.+ Inoculation	3.939	8863	57.00	8806	5
50 Kg N/ fed.+ spraying Mo	4.222	9502	106.00	9396	2
50 Kg N/ fed.+ Inoc.+ Mo.	3.854	8072	162.00	7916	9
35 Kg N/ fed.	3.834	8627	0.00	8627	7
35 Kg N/ fed.+ Inoculation	4.030	9068	57.00	9011	4
35 Kg N/ fed.+spraying Mo.	3.958	8906	106.00	8800	6
35 Kg N/ fed.+ Inoc.+ Mo.	4.366	9824	163.00	9661	1
20 Kg N/ fed.	3.369	7580	0.00	7580	12
20 Kg N/ fed.+ Inoculation	3.481	7832	57.00	7775	11
20 Kg N/ fed.+spraying Mo.	3.542	7970	106.00	7864	10
20 Kg N/ fed.+ Inoc. + Mo.	3.633	8174	163.00	8011	8

Fed. = 4200 m^2.
***Price of sell one ton of green pods during the season = 2250 L.E.**
***Price of sell one package of *Rhizobium* inoculation (200 g) = 7.00 L.E.**
***Price of sell one package of ammonium molybdate (25 g) = 40.00 L.E.**
***Cost of the agriculture worker for each treatment = 50 L.E.**

CONCLUSIONS

This research showed that the treatment of adding 35 kg N/ fed. With bacterial inoculation and molybdenum foliar spraying twice at the rate of 10 Mg/ L. was the highest economic return with saving 30 % from the cost of adding nitrogen fertilization.

REFERENCES

Abdel-Aziz, M. A. and M. F. Salem (2013). Effect of microbial inoculation on reduction of cowpea (*Vigna unguiculata*, L. Walp) chemical fertilizers under newly reclaimed soils condition in Egypt. J. Plant Production, Mansoura Univ.,. 4 (5): 745 – 761.

Achakzai, A. K. K. (2007). Effect of various levels of nitrogen fertilizer on nodulation of pea cultivars. Pak. J. Bot., 39 (5): 1673-1680.

Ahmed, R.; A. R. M. Solaiman; N. K. Halder; M. A. Siddiky and M. S. Islam (2007). Effect of inoculation methods of *Rhizobium* on yield attributes, yield and protein content in seed of pea. J. Soil. Nutr. 1 (3):30-35.

Anandaraj, E. and B. Tech. (2010). Studies on influence of bioinoculants (*Pseudomonas fluorescens, Rhizobium sp.* And *Bacillus megaterium*) in green gram. 1 (2): 95-99.

Anonymous, (2005). Food and Agriculture organization of the United Nations.

Bhuiyan, M. M. H.; M. M. Rahman; F. Afroze; G. N. C. Sutradhar and M. S. I. Bhutyan (2008). Effect of phosphorus, molybdenum and *Rhizobium* inoculation on growth and nodulation on mungbean. J. Soil and Nat. 2(2): 25-30.

Blaine, S. and E. Gregory (2009). Field pea production. North Dakota State University. Fargo, p. 2.

Brkić, S; Z. A. Milaković; M. Kristek and M. Antunović (2004). Pea yield and its quality depending on inoculation, nitrogen and molybdenum fertilization. Plant Soil Environ., 50, (1): 39–45.

El-Sayed, H.; E. A. Amen; A. H. EI-Morsy and Tolba M. H. (2012). Effects of foliar spraying with microelements and different fertilizer sources on quality and yield of *Pisum sativum*, L. plant. International Res. J. Agric. Sci. and Soil Sci., 2(1):17-24.

Figueiredo, M. A.; D. P. Oliveira; B. L. Soares; A. R. Morais; F. M. M. Souza and M. J. B. Andrade (2016). Nitrogen, molybdenum fertilization and inoculation of common bean with *Rhizobium* spp. In two oxisols. Acta Scientiarum. Agron. Maringá, Vol. 38, No. 1, p. 85-92.

Gad, N. and H. Kandil (2013). Evaluate the effect of molybdenum and different nitrogen levels on cowpea (*Vigna unguiculata*). J. Applied Sci., Res. 9 (3): 1490-1497.

Gheeth, R. H. M.; A. M. Ahmed and M. A. Abdel-Aziz (2013). Response of pea plant growth (*Pisum sativum* L.) and its yield for sources, levels of nitrogen and spraying mixture of zinc and manganese. Egypt. J. Appl. Sci., 28 (3) 111-139.

Hristozkova, M.; M. Geneva and I. Stancheva (2006). Response of pea plants (*Pisum sativum* L.) to reduced supply with molybdenum and copper. International J. Agric.And Biology,8(2):218-220.

Jackson, M. L. (1973). Soil Chemical Analysis. Prentic-Hall, Indian.

King, E. J. (1951). Micro-Analysis in Medical Biochemistry. 2nd Ed., Churchil, Landon.

Li, S. X.; Z. H. Wang and B. A. Stewart (2013). Responses of crop plants to ammonium and nitrate nitrogen. Adv. Agron. 118:205-397.

Lodewyckx, C.; J. Vangronsveld; F. F. Porteous; E. R. Moore; S. Taghavi; M. Mezgeay and D. V. der-Lelie (2002). Endophytic bacteria and their potential applications. Critical Reviews in Plant Sci., 21, 583-606.

Marschner, H. (1995). Mineral Nutrition of Higher Plants. 2nd Ed. Academic Press, London.

Ngeno, J.; G. N. Chemining'wa; J. W. Muthomi and S. Shibairo (2012). Effect of *Rhizobium* inoculation and nitrogen fertilizer application on growth, nodulation and yield of two garden pea genotypes. J. Animal &Plant Sci., Vol.15, Issue 2: 21.

Piper, G. S. (1947). Soil and Plant Analysis. Inter science Publishers, Inc. New York. 368 P.

Pergl, F. (1945). Quantitative Organic Micro Analysis. 4th, Ed. J. Churchill Ltd. London.

Rajib, D.; M. M. Reva; S. B. Chattopadhayay and T. Umesh (2015). Synergistic influence of macro nutrient, micro nutrient and bio-fertilizer on root nodulation, growth and yield of garden pea (*Pisum sativum* L.). National environmentalists association. 10(1): 291-297.

Sara, S.; M. Morad and C. M. Reza (2013). Effects of seed inoculation by *Rhizobium* strains on chlorophyll content and protein percentage in common bean cultivars (*Phaseolus vulgaris* L.). International J. Biosciences .(3) : 1-8.

Silva, J. A. and R. Uchida (2000). Essential nutrients for plant growth: nutrient functions and deficiency symptoms. Plant nutrient management in awaii's soils, approaches for tropical and subtropical agric., Chapter 3.

Snedecor, G. A. and W. G. Cochran (1980). Statistical Methods, 7th Ed., The Iowa State Univ., Press, Ames., Iowa, U.S.A.

Tahir, M; M. Mahmood; N. A. Kaleem; R. Nasir; K. Abdul and K. H. Mushtaq (2009). Effect of *Rhizobium* inoculation and N and P fertilization on growth, yield and nodulation of soybean (*Glycine max* L.) in the sub-humid hilly region of Rawalakot Azad Jammu and Kashmir, Pak. African J. Biotechnology., 8 (22): 6191-6200.

Talebipour, N.; H. Aminpanah and M. Rabiee (2015). Effects of *Rhizobium phaseoli* strains and molybdenum foliar application on growth and yield of common bean (*Phaseolus vulgaris* L.). J. Soil Nat. 8(1):1-8.

Vidal, V. C.; J. Frias and I. Sierra (2002). New functional legume foods by germination: effect on the nutritive value of beans, lentils and peas. Eur. Food Res., Technol. 215:472–477.

Wagner, S. C. (2011). Biological Nitrogen Fixation. Nat. Education Knowledge. 3(10):15.

Zaghloul, R. A.; H. E. Abou-Aly; R. M. El-Meihy and M. T. El-Saadony (2015). Improvement of growth and yield of pea plants using integrated fertilization management. Univ. J. Agric. Res., 3(4): 135-143.

أستجابة نبات البسلة لمستويات التسميد النتروجينى والتلقيح البكتيرى والرش بالمولبدنيوم على النمو والمحصول الأخضر والجاف ومكوناتهما

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أجريت هذه الدراسة بمزرعة بحوث الخضر بقها – معهد بحوث البساتين – مركز البحوث الزراعية – محافظة القليوبية خلال الموسم الشتوى ٢٠١٤/٢٠١٥ – ٢٠١٥/٢٠١٦ بهدف دراسة تأثير ثلاث مستويات من التسميد الأزوتى هى ٢٠، ٣٥ ،٥٠ (الموصى به) كج وحدة أزوت/ فدان مع التلقيح البكتيرى الخاص بالبسلة *Rhizobium leguminosarum* صنف ماستر بى و الرش مرتين بعنصر المولبدنيوم بتركيز ١٠ ملليجرام/لتر والتراكيب المختلفة بينهم على صفات النمو الخضرى والمحصول الأخضر والجاف (طن/ فدان). وقد وصممت التجربة بنظام القطاعات الكاملة العشوائية في ثلاث مكررات. أظهرت النتائج المبينة ان زيادة مستوى التسميد الأزوتى من ٢٠ الى ٥٠ كجم ازوت /فدان منفرداً أدى الى زيادة معنوية فى النمو الخضرى ومحصول القرون الخضراء ومواصفاتهما ومحصول البذور الجافة (طن /فدان) ومحتوى البذور من النتروجين والبروتين والفسفور والبوتاسيوم (%). وكانت البذور الأبكر فى الأنبات هى الناتجة عن التسميد بمعدل ٣٥ كجم ازوت /فدان فى كلا الموسمين بالمقارنة بالمستويين الأخرين (٢٠ و ٥٠ كجم ازوت /فدان). أظهرت النتائج أيضاً أن التلقيح بالريزوبيوم أعطى أفضل نتائج للنمو ومحصول القرون الخضراء ومحصول البذرة ومواصفاتهما أضافة الى نسبة الأنبات والتبكير فى الأنبات وطول النبته بأضافة ٣٥ كجم ازوت /فدان بالمقارنة بتلك المعاملة مع مستويين التسميد الأزوتى الآخرين. بينما كان الرش بالمولبدنيوم مرتين بمعدل ١٠ ملليجرام /لتر أدى الى زيادة معنوية بزيادة التسميد الأزوتى من ٢٠ الى ٥٠ كجم ازوت /فدان فى جميع الصفات المدروسة. ومن ناحية أخرى وجد أن أضافة ٥٠ كجم ازوت /فدان مع الرش بالمولبدنيوم أعطت زيادة معنوية فى كل الصفات الخاصة بتلك الدراسة مقارنة بباقى المعاملات. أظهرت النتائج أن أضافة ٣٥ كجم أزوت /فدان مع التلقيح بالريزوبيوم والرش بعنصر المولبدنيوم بتركيز ١٠ ملليجرام/لتر مرتين ادت الى يادة معنوية فى محصول البسلة الكلى سواء الاخضر او الاجاف اضافة الى مواصفاتهما مقارنة بنفس التوليفة مع المستويين الاخرين للتسميد الازوتى (٢٠ و ٥٠ كجم ن / فدان) . عموما فالتوليفة المكونة من اضافة ٣٥ كجم ن فدان والتلقيح بالريزوبيوم والرش بالمولبيدنيوم مرتين بمعدل ١٠ ملليجم كانت الاعلى عائدا اقتصاديا مع توفير ٣٠ % من التسميد الازوتى (الفقرة بعد التعديل)

- الكلمات الدالة : البسلة – مستويات النتروجين – تلقيح بالريزوبيوم – رش ورقى - المولبدنيوم - مزج