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INFLUENCE OF BIO FERTILIZERS ON PLANT GROWTH OF BEAN (*Lablab purpureus* (L).

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ABSTRACT

The present study was elucidated the effects of bio fertilizers on plant growth of **(***Lablab purpureus* (L). COGB14Verity. The research was conducted during the Rabi season 2016 to 2017. At the field experimental centre Department of Botany, Arignar Anna Arts and Science College, Villupuram, Tamil Nadu. The data were recorded on morphological characters based on the mean performance of the treatment (T4 -AMF+AZOS+AZOTO) was found best treatment for plant growth. Compare to the other treatments and control. The obtained results showed that the germination percentage, shoot length, root length, fresh weight, dry weight and leaf area. Interaction effect of bio fertilizers was significant for all characters. Thus it, indicates that the process of bio fertilizers, may be better option for the seed growers, to achieve seed yield and yield components in **(***Lablab purpureus* (L). COGB14 Verity.

Keywords: Arbuscular mycorizha, Endophytic, bio fertilizers, Interaction

1.INTRODUCTION

Beneficial interactions of plant and microbe that promote plant health and development have been the subject of considerable study. At the most basic level, entophyte simply means the location of an organism, with "**endo**" means "**inside**" and "**phyte**" means "**plants**". Therefore, endophyte refers to organisms that live within plants.Bacteria and fungi are the most common organisms associated with the term endophyte. Endophytic organisms associated with plants are varied and complex. Endophytic microbes occupy a relatively privileged niche within plant and usually contribute to plant health. Some groups of endophytic microorganisms have been believed to be mutualists that protect plants against biotic stresses. Co-evolution may exist between endophytes and their host in resist to environmental stresses.Endophytic bacteria help to enhance the nutrient availability and fix nitrogen for plants. Recently, studies have indicated that bacteria colonizing the plant interior are able to improve plant growth and suppress pathogen. Competitions between endophytic bacteria and pathogens are observed due to the limited nutrient supply inside plant tissue. Although the facts of entophytic bacteria reducing the negative impact of plant pathogen have been well documented, few reports indicate that plant pathogens have significant influence on endophytic bacteria. Early evidence for non-symbiotic nitrogen fixation was provided by studies of N balance in various ecological studies. Different crops and grasses, such as sugar cane in Brazil, wetland rice in Asia, and some cereal field in Canada, were observed growing healthy without artificial nitrogen input. Those plants were thought to benefit from the endophytic nitrogen fixers. Thus, the nitrogen fixation bacteria associated with non-legume plant caught people's attention. The ecological and economic importance of nitrogen fixation in rhizobium-legume symbiosis has earned research attention for long time. In legumes, the endophytic bacteria - rhizobium stimulates the plants to develop root nodules. In root nodules, the bacteria inhabit and construct a co-metabolic system with the legumes; so as to form a well-developed symbiosis. This process is highly efficient and provides significant proportion of plant nitrogen. Recent work has proved that significant N fixation processes also exist in some legumes, particularly sugar cane, rice and maize.The study on endophytic diazotrophic bacterium-Azospirillum is a growing interest in diazotrophic bacteria associated with graminaceous plants was manifested all over the world. Azospirillum spp. These spread from plant generation to plant generation via seeds, vegetative propagation and dead plant material and possibly by sap feeding insects. On the other hand, Azospirillum enters host plants via seeds or wounds. Bacterial mechanisms of plant growth promotion include biological nitrogen fixation (BNF), synthesis of phytohormones, environmental stress relief, synergism with other bacteria-plant interactions, inhibition of plant ethylene synthesis, as well as increasing availability of nutrients like

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phosphorus, iron and minor elements, and growth enhancement by volatile compounds. Soil is the habitat for plant roots, micro flora (bacteria, actinomycetes, fungi and algae), micro fauna and macro fauna. The zone of soil under the influence of root is called the "rhizosphere". This area of activated microbial populations can extend more than 5 mm from the root surface. It is now recognized that the "rhizosphere effect" is mainly due to the exudates from the roots, which attract soil microorganisms. These microorganisms play vital roles in physiological processes in the ecosystem of plants growing in soil. The rhizosphere bacteria, actinomycetes and fungi carry out a range activity of great relevance to the plant growth, plants disease development or protection of plants from the pathogens. Based on these relationship of microorganisms with plant's root, the rhizosphere organisms can be categorized into saprotrophs, usually opportunists leaf benefactors in some situation parasitic symbionts or pathogens, potentially harmful to the plants; and mutualistic symbionts which develop activities beneficial to plant growth. These microorganisms interact with both plant roots and soil constituents in the rhizosphere.

Many PGPR (Plant Growth Promoting Rhizobacteria) show great promise as potential inoculants for agricultural uses and environmental protection and play critical role in maintaining the sustainability of agro ecosystems. However, the current use of PGPR in agriculture is somewhat poor despite numerous reports on their proven performance under laboratory conditions. PGPR possess the ability to colonize and establish an on-going relationship with plants, resulting in better root growth, more biomass, and a substantial increase in crop yield. In this context, significant effects of PGPR have been observed on various agricultural crops, including legumes, cereals, and noncereals, and some other important plant species. The most important interactions developing among plant and microbes in the rhizosphere can be classified into three main groups, plant-plant interactions caused by overlapping rhizospheres, which results in competition for nutrients, root-microorganisms interactions, determined by plant activities that stimulate microorganisms to grow around the roots (rhizosphere effect) and by microbial activities that affect plant development, either by benefiting the plants or by inducing disease, and microbe-microbe interactions, which include both synergistic and antagonistic activities

Lablab bean (*Lablab purpureus L*).

Lablab bean is a twining vine with leaves divided into 3 leaflets, and attractive bright purple flowers and purple pods. The vine becomes woody and can reach more than 30 Ft. in length. The leaflets are purplish green, broad oval or triangular in shape and 3-6 in long. Flowers are typically shaped like pea flowers, a rich, brilliant purple and arranged in loose clusters on long stems that extend above the foliage. For this reason, Lablab bean is frequently grown as an ornamental vine. The pods are just as showy as the flowers. They are flat and curved, about 3 in long, bright purple. The beans inside are dark It is a perennial herb, frequently grown as an annual. Usually twining to reach 5-29 feet, but bushy, semi-erect, and prostrate forms exists. Probably no other legume shows such variation in form and habit. The tap-root is well developed with many laterals and well developed adventitious roots. Purse glove 1968 has recognized two types of Lablab in India and is sometimes considered as distinct species. They are: Dolichos lablab var. typicus Prain: It is commonly called Lablab bean, Bonavist bean, Hyacinth bean, Indian butter bean (Hindi-Sem; Bengali-Shim; Gujarathi-Val; Marathi-Pavta; Telugu-Chikkudu; Tamil-Avarai; Kannada-Chapparadavare; Malayalam- Avara.

A perennial twining herb, cultivated mostly as an annual, distributed throughout the tropical and temperate regions of Asia, Africa and America. In India, it is grown as a garden crop. Several types differ in colour of flowers, size, shape and texture of pods and size and colour of seeds. A type with showy purple flowers is cultivated as an ornamental plant in temperate regions. The pods are white, green or purple-margined. Seeds white, yellow, brownish, purple or black. Dolichos lablab var. lignosus Prain: It is commonly known as Australian pea, Field Bean. (Hindi - Ballar; Gujarati - Val; Telugu - Anumulu; Tamil - Mochai; Kannada - Avare; Malayalam - Mochakotta). It is a semi-erect, bushy, perennial herb, cultivated as an annual. It shows little or no tendency to climb. Leaflets innately trifoliate, smaller than those of var. typicus. Flowers borne on a straight upright stalk, often a foot high on which they open in succession. Pods oblong, flat and broad, firm-walled and fibrous contain 4-6 seeds with their long axis at right angles to the suture.

Seeds almost rounded white, brown or black. The plant emits a characteristic odour.lored with a conspicuous white eye. The pod is widely eaten in India. It is very difficult to estimate the total size of green inputs market in India because of its diversity in terms of products and also due to the nature of it being unorganized market. Green inputs into agriculture include bio-fertilizers, bio-pesticides, compost, Farm Yard Manure (FYM), green manure etc. As most of this inputs are either not traded and even if they are traded, it is only at informal levels available information regarding production capacity, demand and sales is at best sketchy estimation and hence inadequate. The limited number well-established firms that have their presence in this market today as a result it this is predominately controlled by the small and local producers of bio-fertilizer, vermicompost and other input producers who are in large numbers.Biofertilizers are low cost, renewable sources of plant nutrients. These are selected strains of beneficial soil microorganisms cultured in the laboratory and packed in suitable carrier. Increased crop production largely relies on the type of fertilizers used to supplement essential nutrients for plants. This investigation aimed at studying the interaction effect of Arbuscular Mycorhizal Fungi (AMF), azospirillum and azotobacter that are likely to possess agronomical beneficial traits viz, N-fixation, P-mobilization and production of plant growth substances for the lablab bean (*Lablab purpureus* L.) crop.

2.MATERIALS AND METHODS

The field experiment was conducted at the Department of Botany, Arignar Anna Arts and Science College, Villupuram, Tamil Nadu. The land was harrowed well and brought to the good tilth. The land was divided into blocks at 1m apart and micro plots of $4.2\times2.8m^2$ were prepared with in each block. 50 cm distance was maintained between two microplots with in each the treatments were allotted randomly. Each micro

plot was surrounded by bund in order to prevent the mixing up inoculum. Lablab bean *Lablab purpureus* (L). Seeds were sowing micro plots with 60cm× 75cm spacing, respectively. The weather is moderately warm with hot summer months.

MATERIALS

Cultivar

The seeds of experimental crop Lablab bean COGB14 *Lablab purpureus (L).* Were obtained from Department of vegetable crops Tamil Nadu Agricultural University (TNAU), Coimbatore, Tamil Nadu, and India.

Bio fertilizers

Bio fertilizers AM Fungi, Azospirillum, and Azotobacter was obtained from the Department of Microbiology Tamil Nadu Agricultural University (TNAU), Coimbatore, Tamil Nadu, India.

METHODS

EXPERIMENTAL DESIGN AND TREATMENTS DETAILS

The experiment design and details are as follows,

Cultivar - Lablab bean COGB14 *Lablab purpureus* (L).

No. of treatments -5

Sampling days – 7^{th}, 15th, 30th, 45th, 60th, 90th DAS

T1: AM Fungi alone
T2: Azospirillum alone
T3: Aztobacter alone
T4: AMF+AZOS+AZOTO+
T5: Control (uninoculated)

GERMINATION STUDIES

Lablab bean COGB14 *Lablab purpureus* (L) seeds were surface sterilized with 0.2 per cent of $HgCl_2$ for two minutes and they were thoroughly washed with tap water. The seeds were equispacially arranged in plastic cup filled with garden soil and they were treated with different Bio fertilizers such as AM Fungi, Azospirillum, Azotobacter and AMF+AZOS+AZOTO. The e control set was maintained by using tap water. Five replicates were maintained for each treatment seventh day, the germination percentage, shoot length, root length, total leaf area, seedling fresh weight, seedling dry weight were taken. From these data, the following values of vigor index, and tolerance index were calculated.

Germination percentage

The number of seeds germinated in each concentration was counted on the 7^{th} day and the germination percentage was calculated by using the following formula

$$\text{Germination percentage} = \frac{\text{Number of seeds germinated}}{\text{Total number of seeds sown}} \times 100$$

Shoot and root length (cm/seedling)

Twenty seedlings were taken from each treatment and their shoot length and root length were measured by using a cm scale and the values were recorded**.**

Total leaf area

The total leaf area was calculated by measuring the length and width of the leaf as described by Yoshida *et al.* (1972).

$$\text{Leaf area } (cm^2) = K \times \text{length} \times \text{breadth}$$

Where

K = Kemp's constant (for dicot leaves 0.66)

Fresh weight (g/seedling)

Ten seedlings were collected from each treatment and their fresh weights were measured with the help of an electrical single pan balance.

Dry weight (g/seedling)

The same seedlings used for fresh weight were kept in hot air oven at 80°C for 24 hours. Then, the seedlings were taken from the oven and kept in desiccators for some time. Their dry weights were taken by using an electrical single pan balance.

3.RESULTS

The present investigation deals with the effects of various Bio fertilizer treatments on seed germination, growth parameters such as shoot length, root length, fresh weight, dry weight and total leaf area of components of Lablab bean (*Lablab purpureus* L). The results are presented in this chapter. The influence of AM fungi Azospirillum and Azotobacter on the plant lablab bean (*Lablab purpureus* L.) showed the order of increasing values on all the growth parameters under investigation. The highest seed germination percentage was recorded in T_4 treatment, with comparison of other treatments.

Shoot length

The influence of biofertilizer and AMF fungi treatments on Lablab bean (*Lablab purpureus* L) of shoot length at 7, 15, 30, 60 and 90days were presented on Table 2. The maximum shoot length was observed on T_4 treatment (7.8, 19.6, 25.3, 34.7 and 46.3 cm/plant) respectively, when compare to other treatments

Root length

The influence of biofertilizer and AMF fungi treatments on Lablab bean (*Lablab purpureus* L) of root length at 7, 15, 30, 60 and 90days were presented on Table 3. The maximum root length were observed on T_4 treatment (10.8, 20.3, 23.5, 32.0 and 37.6 cm/plant) respectively, with comparison of other treatments

Total leaf area

The influence of biofertilizer and AMF fungi treatments on Lablab bean (*Lablab purpureus* L) of total leaf area at 7, 15,

30, 60 and 90days were presented on Table 4. The maximum total leaf area were observed on T_4 treatment (13.5, 20.3, 37.4, 41.5 and 47.5 cm^2/plant) respectively, with comparison of other treatment

Shoot fresh weight

The application of biofertilizer and AMF fungi treatments on Lablab bean (*Lablab purpureus* L) of shoot fresh weight at 7, 15, 30, 60 and 90days were presented on Table 5. The maximum shoot fresh weight were observed on T_4 treatment (750, 793, 842, 853, and 862 g/plant) respectively, with comparison of other treatment

Shoot dry Weight

The application of biofertilizer and AMF fungi treatments on Lablab bean (*Lablab purpureus* L) of shoot dry weight at 7, 15, 30, 60 and 90days were presented on Table 6. The maximum shoot dry weight were observed on T_4 treatment (150, 182, 205, 216 and 253 g/plant) respectively, with comparison of other treatment.

Root fresh weight

The influence of biofertilizer and AMF fungi treatments on Lablab bean (*Lablab purpureus* L) of root fresh weight at 7, 15, 30, 60 and 90days were presented on Table 7. The maximum of root fresh weight were observed on T_4 treatment (265.267, 270,278and289 g/plant) respectively, when compare other treatment.

Root dry weight

The influence of biofertilizer and AMF fungi treatments on Lablab bean (Lablab purpureus L) of root dry weight at 7, 15, 30, 60 and 90days were presented on Table 8. The maximum of root dry weight were observed on T4 treatment (10.3, 11.5, 12.5, 13.4 and 13.9 g/plant) respectively, when compare to other treatment.

Table 1. Germination percentage of sunflower

Sl. No.	Treatment	Germination (%)
1	T_1	99.6
2	T_2	99.5
3	T_3	99.7
4	T_4	100
5	T_5	98.6

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Rows	2799.626	4	699.9064	282.7162	1.28E-14	3.006917
Columns	130.6216	4	32.6554	13.19064	6.13E-05	3.006917
Error	06.6104	16	2.47565			
Total	2969.858	24				

Table 2. Shoot length (cm/plant)

Treatments	7 DAS	15 DAS	30 DAS	60 DAS	90 DAS
T_1	6.4	16.4	23.1	29.5	37.8
T_2	6.0	15.5	22.5	28.4	35.5
T_3	6.1	14.8	21.5	27.2	34.4
T_4	7.8	19.6	25.3	34.7	45.3
T_5	5.7	15.1	20.2	26.3	33.2

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Rows	2799.626	4	699.9064	282.7162	1.28E-14	3.006917
Columns	140.6216	4	32.6554	13.19064	6.13E-05	3.006917
Error	05.6104	16	2.47565			
Total	2969.858	24				

Table 3. Root length (cm/plant)

Treatments	7 DAS	15 DAS	30 DAS	60 DAS	90 DAS
T_1	8.9	15.3	18.6	27.3	28.6
T_2	8.7	16.1	17.9	26.4	27.9
T_3	8.5	16.8	18.6	25.6	28.3
T_4	10.8	20.3	23.5	32.6	37.6
T_5	7.9	14.3	17.3	20.4	22.4

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Rows	515.6815	3	171.8938	57.12182	2.24E-07	3.490295
Columns	202.873	4	50.71825	16.85412	7.25E-05	3.259167
Error	06.1411	12	3.00925			
Total	754.6655	19				

Table 4. Total leaf area (cm^2/plant)

Treatments	7 DAS	15 DAS	30 DAS	60 DAS	90 DAS
T_1	9.5	23.3	26.2	36.4	38.4
T_2	8.9	21.2	25.2	34.9	37.4
T_3	9.7	20.3	24.4	35.3	35.5
T_4	13.5	29.3	37.4	41.5	47.5
T_5	7.9	17.5	21.4	30.5	35.3

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Rows	876.234	3	292.078	161.2503	5.84E-10	3.490295
Columns	369.42	4	92.355	50.9873	1.96E-07	3.259167
Error	21.736	12	1.811333			
Total	1267.39	19				

Table 5. Shoot fresh weight (g/plant)

Treatments	7 DAS	15 DAS	30 DAS	60 DAS	90 DAS
T_1	665	775	783	787	867
T_2	660	760	780	785	844
T_3	657	780	781	784	850
T_4	750	793	842	853	862
T_5	650	762	769	771	794

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Rows	13258.6	3	4419.533	16.95527	0.00013	3.490295
Columns	8587.3	4	2146.825	8.236165	0.001955	3.259167
Error	3127.9	12	260.6583			

Table 6. Shoot dry weight (g/plant)

Treatments	7 DAS	15 DAS	30 DAS	60 DAS	90 DAS
T_1	128	175	188	198	242
T_2	126	170	186	197	231
T_3	125	179	190	195	241
T_4	150	182	205	216	253
T_5	123	155	163	175	184

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Rows	9140.15	3	3046.717	48.09972	5.81E-07	3.490295
Columns	4357.5	4	1089.375	17.19839	6.56E-05	3.259167
Error	760.1	12	63.34167			
Total	14257.75	19				

Table 7. Root fresh (g/plant)

Treatments	7 DAS	15 DAS	30 DAS	60 DAS	90 DAS
T_1	254	261	267	269	276
T_2	252	260	266	268	274
T_3	250	259	265	260	272
T_4	265	267	270	278	289
T_5	240	243	252	259	265

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Rows	781.4	3	260.4667	40.53956	1.48E-06	3.490295
Columns	929.7	4	232.425	36.1751	1.32E-06	3.259167
Error	77.1	12	6.425			
Total	1788.2	19				

Table 8. Root dry weight (g/plant)

Treatments	7 DAS	15 DAS	30 DAS	60 DAS	90 DAS
T_1	8.2	10.3	11.3	11.4	12.3
T_2	8.9	10.1	11.2	11.0	12.2
T_3	8.0	10.0	11.1	10.9	12.1
T_4	10.3	11.5	12.5	13.4	13.9
T_5	7.5	9.3	10.2	10.5	11.8

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Rows	12.402	3	4.134	80.27184	3.28E-08	3.490295
Columns	12.57	4	3.1425	61.01942	7.11E-08	3.259167
Error	0.618	12	0.0515			

4.DISCUSSION

The authors suggested that the biofertilizer help to microorganism in the faster decomposition of organic matter available in the soil, thereby increasing the availability of nutrients and ultimately in higher plant growth. These finding are in accordance with the findings of Mehta *et al.* (2010) in fenugreek, Thenmozhi (2010) in amaranth, in spinach, Meena *et al.* (2013) in fenugreek and Kavitha *et al.* (2013) in amaranth. Moreover, the inoculated AMF plant had a significant positive effect on all growth parameters regardless of single or mixed-species inoculation (Singh *et al.,* 2008; Cho *et al.,* 2009; Gogoi and Singh, 2011 and Ortas and Ustuner, 2014). However, (El- Khateeb *et al.,* 2010) which proved that bio fertilizers significantly increased the fresh and dry weights of roots. In contrast, the results disagrees with the study of Jnawali *et al.* (2015) which proved that combined application of bio-fertilizer with 50% of chemical fertilizers (N and P) has a positive role for safflower growth in comparison with chemical fertilizers alone. Inoculation of maize with AMF and BF have beneficial effect on supplying the plant with continuously available essential nutrients by which reflected on the plant growth and metabolism (Mazen *et al.,* 2018).

The dual inoculation of seed with Vesicular Arbuscular Mycorrhiza and Rhozobia enhanced the growth and quality traits i.e. protein and oil contents (Yadav and Ashok, 2015). Similarly Researches in the past few decades on various aspects of root symbionts have shown that dual interaction of AM fungi and Rhizobium has improved the growth, nodulation and yield (Talaat and Abdallah, 2008). According to Lokshman and Kadam (2011) that plants inoculated with both rhizobial and mycorrhizal symbiosis improved growth, nodulation and nitrogen fixation. Jarande et al. (2006) who stated that treatments had higher values of growth parameters including plant height, number of seeds per plant and pod length. Recent study suggest that the Effect of biofertilizer on the dry weight of plant was due to increased nitrogen uptake and the growth rate improvement. Effect of biostimulant on the dry weight of plant was due to increased nitrogen uptake (Kusuma *et al.,* 2019).

5.CONCLUSION:

The study concluded that bio inoculant treatment is promising for *Lablab purpureus*; furthermore, bio inoculants are eco-friendly and inexpensive compared to chemical fertilizers. Inoculation of *Lablab purpureus* with AMF and biofertilizer have beneficial effect on supplying the plant with continuously available essential nutrients by which reflected on the plant growth and metabolism. This will reduce the needs for chemical fertilizers, and the kind and low quantity of chemical fertilizer have to be use will be to give the most satisfactory yields.

5.REFERENCE

Cho EJ, Lee DJ, Wee CD, Kim HL, Cheong YH, Cho JS, Sohn BK (2009) Effects of AMF inoculation on growth of Panax ginseng C.A. Meyer seedlings and on soil structures in mycorrhizosphere. Scientia Horticulturae 122: 633–637.

El-Khateeb, M. A., El-Madaawy, E., & El-Attar, A. (2010). Effect of some biofertilizers on growth and chemical composition of Chamaedorea elegans Mart Seedlings. Journal of Horticultural Science & Ornamental Plants. 2: 123-129.

Gogoi P, Singh RK (2011) Differential effect of some arbuscular mycorrhizal fungi on growth of Piper longum L. (Piperaceae). Indian Journal of Science and Technology 4 : 119-125.

Jarande, N.N., P.S. Mankar, V.S. Khawale, A.A. Kanase and J.T. Mendhe. 2006. Response of chickpea (Cicer arietinum L.) to different levels of phosphorus through inorganic and organic sources. J. Soils and Crops, 16(1): 240-243.

Jnawali, A. D., Ojha, R. B., & Marahatta, S. (2015). Role of Azotobacter in soil fertility and sustainability–A Review. *Advances in Plants & Agriculture Research*. **2**(6): 1-5.

Kavitha, Srinivasan, Sivagami, Ranjini. Individual and combined effect of biofertilizer, chemical fertilizer and vermicompost on Amaranthus tristis. Int. J Pharm. Sci. Rev. Res. 2013; 20(2):190-195.

Kusuma, M.V., J. Venkatesha, P.M. Ganghadarappa., J.S. Hiremath, A.B. Mastiholi and G. Manjunatha,2019. Effect of Integrated Nutrient Management on Growth and Yield of Fennel (Foeniculum vulgare Mill.), Int.J.Curr.Microbiol.App.Sci (2019) 8(1): 2782-2794.

Lokshman, H.C. and M.A. Kadam. 2011. Influence of AM fungi and rhizobium on the growth and nutrient uptake of Lense esculenta. Bioscience Discovery, O2(2): 256 -260.

Mazen, M. B. H., Taha Ramadan, Nivien A. Nafady, Amira Zaghlol and Sedky H.A. Hasan, 2018. Comparative Study on the effect of Chemical Fertilizers, Bio-fertilizers and Arbuscular Mycorrhizal fungi on Maize Growth, Biological Forum – An International Journal 10(1): 182-194.

Meena SS, Mehta RS, Bairwa M, Meena RD. Productivity and profitability of fenugreek (Trigonella foenum-graecum L.) as influenced by biofertilizers and plant growth regulators. Legume Res. 2013; 37(6):646- 650.

Mehta RS, Patel BS, Meena SS, Meena RS. Influence of nitrogen, phosphorus and bio-fertilizers on growth characters and yield of fenugreek (*Trigonella foenumgraecum* L.). Journal of spices and Aromatic Crops. 2010; 19(1, 2):23-28.

Ortas I, Ustuner O (2014) the effects of single species, dual species and indigenous mycorrhiza inoculation on citrus growth and nutrient uptake. European Journal of Soil Biology 63: 64-69.

Singh S, Pandey A, Chaurasia B, Palni LMS (2008) Diversity of arbuscular mycorrhizal fungi associated with the rhizosphere of tea growing in 'natural' and 'cultivated' ecosites. Biology and Fertility of Soils 44: 491–500.

Talaat, N.B. and A.M. Abdallah. 2008. Response of Faba Bean (Vicia fava L.) to dual inoculation with rhizobium and VA Mycorrhiza under different levels of N and P fertilization. J. Applied Sci. Res., 4(9): 1092-1102.

Thenmozhi R, Rejina K, Madhusudhanan K, Nagasathya K. Study on effectiveness of various biofertilizers on the growth and biomass production of selected vegetables. Research Journal of Agriculture and Biological Sciences, 2010; 6(3):296-301.

Yadav, A and A. Ashok. 2015. The associative effect of arbuscular-mycorrhizae with Trichoderma viride and Pseudomonas fluorescensin promoting growth, nutrient uptake and yield of Arachishy pogaea L. New York Science Journal, 8(1): 35-41.