Journal of ENVIRONMENTAL Treatment Techniques

J. Environ. Treat. Tech.
ISSN 2309-1185

Journal web link: http://www.jett.dormaj.com/

Efficient of biofertilizers on growth and yield characteristics of groundnut *Arachis hypogaea* L.

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Receive: 08/07/2014 Accept: 13/09/2014 Published: 30/10/2014

Abstract

One of the major concerns in today's world is the pollution and contamination of soil. An answer to this is the bio-fertilizers an environmentally friendly fertilizers. The main sources of bio-fertilizers are bacteria, fungi and cyanobacteria. Now used in many countries bio-fertilizers are organisms that enrich the nutrient quality of soil. Hence the present study has been carried to find out the effect of Bio-fertilizers on various stages of Groundnut growth. Germination studies were conducted with various Bio-fertilizers applied in pots containing soil. Morphological parameters, photosynthetic pigments and bio-chemical parameters were observed and recorded on seedling, flowering and yielding stage. Yield parameters were recorded at the time of Harvest. These parameters were found to increase on the application of Bio-fertilizers than in control.

***Keywords*:** Bio-fertilizers, pollution and contamination, seedling and groundnut.

1 Introduction

The United Nations Food and Agriculture Organization (FAO) estimates that the total demands for agricultural products will be 60 per cent higher in 2030 than present time and more than 85 per cent of this additional demand will come from developing countries, for over half a century the world has relied on increasing crop yields to supply an ever increasing demand for food. World cereal production increased significantly during last two decades. This dramatic increase in world grain production was the result of a 122 per cent increase in crop yields. However this trend of grain production cannot be maintained due to decreasing cultivable land for rapid urbanization.

Rhizobium is able to a symbiosis with leguminous plants. They elicit the formation of specialized organs called nodules, roots or stems of their hosts. In which they reduce atmospheric nitrogen and make it available to the plants. Symbiotic nitrogen fixation is an important source of nitrogen and the various legume crops and pasture species often fix as much as 200 to 300 kg nitrogen / hectare (People *et al.,* 1995). In 1999 world consumption of fertilizer nitrogen was 88 million tons and apart from the consumption of non renewable energy sources. Environmental pollution from fertilizer nitrogen escaping the root zone in high because in many causes nitrogen fertilizers are not used efficiently by crops (peoples *et al.,* 1994). Biofertilizers are non-symbiotic and symbiotic microbes like *Azospirillum sp, Bacillus polymyxa, Pseudomanas striata* and *Azotobacter*, in the soil (Saxena *et al*., 1993) that stimulate plant growth and contribute to the improvement of ecosystem.

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Pulses are of the most important food crops in India and from all integral part of the cropping system of farmers all over the country. They belong to the family leguminaceae. They are next to levels as an important nutrient scientist in recent years have also stressed the values of grain legumes as sources of protein and fiber and drawn attention to the complementary nature of their amino acid composition. Pulse crops are primarily grown under rain fed condition and on low fertility neglected soil in India. Even then India is the largest producer and consumer of the world (Saraswathi *et al.,* 2004).The present investigation has been carried out to explore the response of bio-fertilizers (*Rhizobium leguminosarum and Bacillus megaterium*) in pot culture condition on growth photosynthetic pigments, biochemicals and yield of Ground nut (*Arachis hypogaea.L.).*

2 Materials and Methods

This experiment was carried to find out the effect of different bio-fertilizers on morphological parameters, photosynthetic pigments, biochemical analysis and yield parameters of groundnut with the application of bio-fertilizers. The experiment consist the pulse crop *Arachis hypogeae* L. variety VR2 was laid out under split pot design condition. The experiment was conducted with control -T1, and the soil application of bio-fertilizers T2-(*Rhizobium leguminosarum*), T3- (*Bacillus megaterium*), T4-(*Rhizobium leguminosarum* and *Bacillus megaterium*). Five plant samples were randomly collected at the time of seedling, flowering and yielding stages they were used for observations of various morphological parameters, photosynthetic pigments and biochemical analysis of the plants. Yield parameters were observed in harvesting stage.

Plant Shoot length and root length were measured by using centimeter scale and their Fresh weight was taken by using an electrical single pan balance. The fresh plant

materials were kept in a hot air oven at 80^{o} C for 24 hrs and then their dry weight were also determined. The photosynthetic pigments namely Chl -a, Chl - b and Carotenoides were measured from the fresh leaves by the method of Wettstein formula (Wettstein et al., 1957). Protein content was determined according to the method of Lowry *et al* (1951). Amino acid content was analyzed by Moore and Stein (1948). Total sugar content was analyzed in Nelson (1944) and starch content was analyzed by Dubois (1956). Yield attributing characters like Number of pods per plant, seeds per plant, weight of pods per plant, weight of seeds per plant and weight of 100 seeds was counted at physiological maturity of plant. To analyze the variance of data and to compare the mean values (Duncan test at the probability level of 5%), with the help of SPSS 16 software. Means and standard deviation were calculated from 3 replicates.

3 Results and discussion

The effect of bio-fertilizers on the morphological parameters of groundnut at various stages of growth (seedling, flowering and yielding) is shown in Table-1, 2, 3. The combined application of biofertilizers T4 (*Rhizobium leguminosarum* and *Bacillus megaterium)* increased root length, shoot length, number of lateral root, total leaf area, fresh weight and dry weight compared with other application and control. Hassan et al (2012) reported that bio-fertilizer treatments enhance plant height, yield and mineral compositions. The Biofertilizers stimulate the growth, yield and chemical constituents. It has been reported that inoculation chickpea of with both *Pseudomonas fluorescense* and *Rhizobium* enhances stem height; root length and dry weight (Dileep Kumar et al., 2001). Mekki and Amel (2005) also claimed that application of biofertilizer increases plant height and dry weight of soybean.

The result on the effect of biofertilizers on the photosynthetic pigments and biochemicals of groundnut at various stages of its growth (seedling, flowering and yielding) stages are shown in Table–4, 5, 6. The combined application of Biofertilizers (*Rhizobium leguminosarum* and *Bacillus megaterium)* increase chlorophyll 'a' and 'b', carotinoides, protein, amino acid, total sugar and starch were recorded in groundnut compare with other treatments and control. Mohammadi *et al*., 2010 reported that the highest sugar, protein, starch contents, nodule weight and seed nitrogen, potassium, phosphorus of chickpea were obtained from combined application of phosphorus solubilizing bacteria and *Rhizobium*. Studies have shown that the biofertilizers application of pea plants increased content of carbohydrate, reducing sugar, total free amino acids, total protein, total leaf area and total free phenolics (Namdeo *et al.,* 1991). The co-inoculation of *Rhizobium* and *Pseudomonas* strains increased nodulation, leaf chlorophyll content and other growth factors under greenhouse conditions (Samavat *et al*., 2012).

Biofertilizers application of yield parameter in groundnut is shown in Table– 7. The highest number of pods, number of seeds, weight of pods, weight of the seeds, and weight of 100 seeds were recorded in the combined application of Biofertilizer T4-*(Rhizobium leguminosarum* and *Bacillus megaterium)* than in single application T2-(*Rhizobium leguminosarum*), T3-(*Bacillus megaterium*) and control. The combined inoculation of *mesorhizobium* sp. with *P.acruginosa* and *B.megaterium* and *A.chroococcum* showed significant increase in yield of grain and straw of chickpea over control (verma *et al.*, 2013)

Table –1 Effect of biofertilizers (*Rhizobium leguminosarum, Bacillus megaterium and Rhizobium leguminosarum + Bacillus megaterium)* on morphological parameters of groundnut *(Arachis hypogaea* L.*)* at seedling stages.

Treatment	Root length (cm/Plant)	Shoot length (cm/Plant)	No. of lateral root	Total leaf area (cm/Plant)	Fresh weight (g/Plant)	Dry weight (g/Plant)
T_1	5.14	8.23	9.20	173.49	2.235	0.738
T_2	6.12 ± 19.06	8.36 ± 1.57	10.12 ± 10.00	180.6 ± 4.09	2.440 ± 9.17	0.763 ± 3.38
T_3	6.16 ±19.84	8.41 ± 2.18	10.26 ± 11.51	192.4 ± 10.89	2.645 ± 17.00	0.866 ± 17.34
T_4	6.22 ± 21.01	8.48 ± 3.03	10.41 ± 3.03	214.92 ± 23.88	2.951 ± 32.02	0.970 ± 31.43

(±) Percentage over control is expressed in parameter.
T1- Control, T2 - *Rhizobium leguminosarum,* T3 - *Bacillus megaterium,*
T4 - *Rhizobium leguminosarum + Bacillus megaterium*

Table –2 Effect of biofertilizers (*Rhizobium leguminosarum, Bacillus megaterium and Rhizobium leguminosarum + Bacillus megaterium)* on morphological parameters of groundnut *(Arachis hypogaea* L.*)* at flowering stages.

Treatment	Root length (cm/Plant)	Shoot length (cm/Plant)	No. of lateral root	Total leaf area (cm/Plant)	Fresh weight (g/Plant)	Dry weight (g/Plant)
T_1	6.16	14.59	9.36	174.12	6.316	2.239
T_2	7.43 ± 20.61	15.22 ± 4.31	10.49 ± 12.07	192.86 ± 10.76	6.688 ± 5.99	2.350 ± 4.95
T_3	7.92 ± 28.57	15.96 ± 9.38	10.58 ± 13.03	212.93 ± 22.26	6.792 ± 7.53	2.452 ± 9.51
T_4	8.42 ± 36.68	17.22 ± 18.02	11.69 ± 24.89	264.86 ± 52.11	7.706 ± 22.00	2.756 ± 23.09

(±) Percentage over control is expressed in parameter.
T1- Control, T2 - *Rhizobium leguminosarum,* T3 - *Bacillus megaterium,*
T4 - *Rhizobium leguminosarum + Bacillus megaterium*

Table –3 Effect of biofertilizers (*Rhizobium leguminosarum,Bacillus megaterium and Rhizobium leguminosarum + Bacillus megaterium)* on morphological parameters of groundnut *(Arachis hypogaea* L.*)* at yielding stages.

Treatment	Root length (cm/Plant)	Shoot length (cm/Plant)	No. of lateral root	Total leaf area (cm/Plant)	Fresh weight (g/Plant)	Dry weight (g/Plant)
T_1	2.239	6.98	16.32	9.28	173.89	5.892
T_2	2.350 ± 16.33	8.12 ± 4.90	17.12 ± 11.20	10.32 ± 4.53	181.78 ± 5.39	6.210 ± 9.40
T_3	8.23 ± 17.90	17.76 ± 8.82	10.46 ± 12.71	192.16 ± 10.50	6.216 ± 5.49	2.622 ± 18.53
T_4	9.14 ± 30.94	18.24 ± 11.76	11.56 ± 24.56	218.98 ± 25.93	6.623 ± 12.40	2.726 ± 23.23

(±) Percentage over control is expressed in parameter.
T1- Control, T2 - *Rhizobium leguminosarum,* T3 - *Bacillus megaterium,*T4 - *Rhizobium leguminosarum + Bacillus megaterium*

Table – 4 Effect of biofertilizers (*Rhizobium leguminosarum, Bacillus megaterium and Rhizobium leguminosarum + Bacillus megaterium)* on biochemical parameters of groundnut *(Arachis hypogaea* L.*)* at seedling stages.

Treatments	Chl a (mg / g)	Chl b (mg / g)	Carotinoid (mg / g)	Protein (mg / g)	Amino acid (mg / g)	Total sugar (mg / g)	Starch (mg / g)
T_1	0.529	0.428	0.332	1.376	3.262	3.262	0.926
T_2	0.591 ± 11.72	0.491 ± 14.71	0.375 ± 12.95	1.379 ± 0.21	1.379 ± 3.21	3.367 ± 0.21	0.929 ± 0.32
T_3	0.624 ± 17.95	0.498 ± 16.35	0.417 ± 25.60	0.382 ± 0.43	3.399 ± 4.19	3.471 ± 0.29	0.981 ± 5.93
T_4	0.675 ± 27.59	0.512 ± 19.62	0.494 ± 48.79	1.386 ± 0.72	3.472 ± 6.43	3.575 ± 0.39	0.994 ± 7.34

(±) Percentage over control is expressed in parameter.
T1- Control, T2 - *Rhizobium leguminosarum,* T3 - *Bacillus megaterium,*
T4 - *Rhizobium leguminosarum + Bacillus megaterium*

Table – 5 Effect of biofertilizers (*Rhizobium leguminosarum, Bacillus megaterium and Rhizobium leguminosarum + Bacillus megaterium)* on biochemical parameters of groundnut *(Arachis hypogaea* L.*)* at flowering stages.

Treatments	Chl a (mg / g)	Chl b (mg / g)	Carotinoid (mg / g)	Protein (mg / g)	Amino acid (mg / g)	Total sugar (mg / g)	Starch (mg / g)
T_1	1.012	0.569	0.432	1.402	3.321	4.316	1.012
T_2	1.118 ± 20.47	0.675 ± 18.62	0.498 ± 15.27	1.510 ± 7.70	3.498 ± 5.32	4.462 ± 3.38	1.117 ± 10.37
T_3	1.320 ± 30.43	0.747 ± 31.28	0.568 ± 31.48	1.614 ± 15.12	3.596 ± 8.28	4.589 ± 6.32	1.218 ± 20.35
T_4	1.426 ± 40.90	0.879 ± 54.92	0.643 ± 50.92	1.717 ± 22.46	3.594 ± 9.48	4.632 ± 7.32	1.293 ± 27.76

(±) Percentage over control is expressed in parameter.
T1 - Control, T2 - *Rhizobium leguminosarum,* T3 - *Bacillus megaterium,*
T4 - *Rhizobium leguminosarum + Bacillus megaterium*

Table – 6 Effect of biofertilizers (*Rhizobium leguminosarum, Bacillus megaterium and Rhizobium leguminosarum + Bacillus megaterium)* on biochemical parameters of groundnut *(Arachis hypogaea* L.*)* at yeilding stages.

Treatments	Chl a (mg / g)	Chl b (mg / g)	Carotinoid (mg / g)	Protein (mg / g)	Amino acid (mg / g)	Total sugar (mg / g)	Starch (mg / g)
T_1	0.620	0.431	0.421	0.122	2.326	3.129	0.835
T_2	0.723 ± 16.61	0.509 ± 18.99	0.482 ± 14.48	1.192 ± 6.23	2.432 ± 4.55	3.216 ± 2.78	0.894 ± 7.06
T_3	0.794 ± 28.06	0.529 ± 22.73	0.528 ± 25.41	1.275 ± 13.63	2.512 ± 7.99	3.312 ± 5.84	0.922 ± 10.41
T_4	0.814 ± 31.29	0.618 ± 43.38	0.631 ± 49.88	1.362 ± 21.39	2.641 ± 9.24	3.322 ± 6.16	0.966 ± 15.68

(±) Percentage over control is expressed in parameter.
T1 - Control, T2 - *Rhizobium leguminosarum,* T3 - *Bacillus megaterium,*
T4 - *Rhizobium leguminosarum + Bacillus megaterium*

Table – 7 Effect of biofertilizers (*Rhizobium leguminosarum, Bacillus megaterium and Rhizobium leguminosarum + Bacillus megaterium)* on biochemical parameters of groundnut *(Arachis hypogaea* L.*)* at harvesting stage.

Treatments	Number of pods / plant	Number of seeds / plant	Weight of pods / plant (g)	Weight of seeds / plant (g)	Weight of seeds / 100 seeds (g)
T1	31.25	64.22	44.75	26.03	44.54
T2	33.00 ± 5.6	68.00 ± 5.88	46.99 ± 5.00	28.13 ± 8.06	45.92 ± 3.09
T3	38.75 ±24.00	73.73 ± 14.80	48.13 ± 7.55	32.05 ± 23.12	46.12 ± 3.54
T4	41.75 ± 33.6	80.60 ± 25.50	51.96 ± 16.11	35.65 ± 36.95	48.68 ± 9.29

(±) Percentage over control is expressed in parameter.
T1 - Control, T2 - *Rhizobium leguminosarum,* T3 - *Bacillus megaterium,*
T4 - *Rhizobium leguminosarum + Bacillus megaterium*

4 Conclusions

Thus the experimental evidences clearly indicated that the application of microbial innoculents of biofertilizers namely *Rhizobium leguminosarum and Bacillus megaterium* enhance growth and yield of groundnut. It is already established that the application of these organisms in the form of bioinoculants showed beneficial effect in blackgram, greengram and other pulse crops. Hence it is justifiably concluded that the said microbial inoculants could be formulated and delivered as biofertilizer bioinnoculents to farmers.

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