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Research Article

INFLUENCE OF VARIOUS BIO-FERTILIZERS ON THE GROWTH AND YIELD OF GROUND NUT, *Arachis hypogeae* L.

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A B S T R A C T

The peanut or ground nut (Arachis hypogeae L.) is a species in the legume or bean family (Fabaceae).The present study was carried out to study the effect of different bio-fertilizers on the growth and yield of ground nut plant. The bio-fertilizers used were Azospirillum, panchagavya, VAM fungi and a mixture of these three fertilizers. Control plant was maintained without any fertilizer application.In Arachis, the germination percentage was higher when the mixture of fertilizers was used. The shoot length, root length, fresh weight and dry weight were found to be maximum in either VAM treated plants or the plants treated with the mixture of fertilizers.The yield was more in Azospirillum treated plants. In case of nodules, in the early stages of growth, more nodules were formed in the Azospirillum treated plants. In later stages, Panchagavya treated plants showed more nodule formation.

INTRODUCTION

Plants are the backbone of life on Earth and an essential resource for humans. Humans obtain many products directly or indirectly from plants (Wangchuk *et al*., 2012;Polunin and Stainton, 1997 and Thalluri, 2016). The plant kingdom contributes immensely to human health when no synthetic medicines were available and when no concepts of surgery existed. There is therefore, need to conserve these plants associated with indigenous knowledge for human development and good health.

Organic farming is a method of crop and livestock production that involves much more than choosing not to use pesticides, fertilizers, genetically modified organisms, antibiotics and growth hormones. Bio-fertilizers are best defined as biologically active products or microbial inoculants viz., formulations containing one or more beneficial bacteria or fungal strains in easy to use and economical carrier materials which add, conserve and mobilize crop nutrients in the soil. Organic fertilizers contain organic compounds which directly or by their decay, increase soil fertility. More commonly known as microbial inoculants, are artificially multiplied cultures of certain soil organisms that can improve soil fertility and crop productivity. Vesicular arbuscularmycorrhizal fungi belong to the class Zygomycetes, order Endogonales (Benjamin, 1979) and family Endogonaceae. Mycorrhizal Fungi are responsible in improving growth of host plant species due to increased nutrient uptake, production of growth promoting substances, tolerance to drought, salinity and synergistic interactions with other beneficial microorganisms (Sreenivasa and Bagyaraj, 1989). Mycorrhizal fungi that grow into the root cortex of the host plant and penetrate root cells to form two kinds of specialized structures, arbuscules and vesicles. Mycorrhizal fungi is specifically designed to reduce transplant stress while improving soil hydration and fertility. Mycorrhizal association can also enable the plant host to access nutrients in an organic form which would be unavailable otherwise (Howeler *et al*., 1981). The soil conditions prevalent in sustainable agriculture are likely to be more favorable to AM fungi than those under conventional agriculture (Smith and Read, 1997).

Panchagavya also contain phosphate solubilizing microorganisms. Phosphorus is a major essential macronutrient for biological growth and development. Panchagavya has played a significant role in providing resistance to pests and diseases, resulting in increased overall yields (Tharmaraj*et al*., 2011 and Sumangala and Patil, 2009). Panchagavya possess the properties of fertilizers and bio-pesticides (Sireesha, 2013). Panchagavya has resulted in positive effect on growth and productivity of crops as reported by Somasundaram*et al*. (2007).

Azospirillum is a gram-negative, microaerophilic, non-fermentative and nitrogen-fixing bacterial genus from the family of Rhodospirillaceae. It is a free-living, plant-growth-promoting bacterium (PGPB) capable of affecting growth and yield of numerous plant species, many of agronomic and ecological significance. They are found in the soil around plant roots and root surfaces (Indu and Savithri, 2003). It also

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produces growth-promoting substances like Indoleacetic acid (IAA), gibberellins and promotes root proliferation (Bhaskar*et al*., 2005 and Ananthanaik, 2006). It increases the rootlet density and root branching resulting in the increased uptake of mineral and water.

MATERIALS AND METHODS

The plant taken for the present study was *Arachis hypogeae* L. belonging to the family Fabaceae. Growth studies were carried out under different treatments of biofertilizers namely Vesicular Arbuscular Mycorrhiza, Panchagavya and *Azospirillum*at different stages of growth of the plants.

Collection of the Seeds

Seeds of *Arachis hypogeae* L. were obtained from Tamil Nadu Agricultural University, Coimbatore.

Collection of bio-fertilizers

The bio-fertilizers such as VAM, Panchagavya and *Azospirillum* were collected from TNAU, Coimbatore.

METHODS

Pot Culture Experiment

The seeds obtained from TNAU, Coimbatore were soaked in different organic fertilizers overnight. Later, the seeds were sown in pots (30cm×30cm×30cm sized pots) containing red soil and sandy soil in the ratio 1:1. The treated pots were maintained in triplicates. The effect of different organic fertilizers on the growth and yield parameters of *Arachis hypogeae* L. was assessed. Neem extract was sprayed at intervals to control the growth of insects.

The Different Organic Fertilizer Treatments Given were

T_0-Control
T_1- Vesicular Arbuscular Mycorrhiza
T_2-Panchagavya
T_3-*Azospirillum*
T_4- VAM + Panchagavya + *Azospirillum*

Growth Parameters

Plant samples were uprooted carefully on the 30thday, 45thday, 60thday and 75thday and the following growth parameters were measured and recorded for all the treatments.

1. Shoot length (cm)
2. Root length (cm)
3. Number of leaves
4. Fresh weight (gm)
5. Dry weight (gm)

Shoot Length

The shoot length of the plants was measured with the help of scale from the shoot collar point to shoot apex and expressed in centimeter. Ten seedlings were randomly selected from each treatment and their shoot length was measured using cm scale and recorded as cm/seedling. Three readings were taken for statistical analysis.

Root Length

The plants were taken from control pot and other treatment pots and washed to get rid off adhering soil particles. Then, the length of the roots was measured with the help of a scale from root collar point to root tip and expressed in centimeter. Ten seedlings were randomly selected from each treatment and their root length was measured using cm scale and recorded as cm/seedling.

Number of Leaves

The number of leaves present in the uprooted plants were calculated.

Fresh Weight

Fresh weight of the plants was measured with the help of an electronic digital balance and expressed in grams.

Dry Weight

The collected plant materials were kept in hot air oven at 55°C for 24 hours. Then, the dry weight of the plants was measured using an electronic digital balance and expressed in grams.

Yield Parameters

Number of fruits

The number of fruits obtained on the60th day and 75th day were calculated for *Arachis hypogeae* L.

Number of Nodules

Nodules were formed in the roots of the groundnut plants and the number of nodules formed were calculated on the 30th, 45th, 60th and 75th day.

Statistical Analysis

The data obtained from various biometric observations were subjected to statistical analysis as per the procedure of Panse and Sukhatme (1978).

RESULTS AND DISCUSSION

The study conducted in the oil-seeded crop *Arachis hypogeae* L. showed the following results.

Growth Parameters

Germination

Germination studies were carried out in *Arachis hypogeae* L. by soaking the seeds overnight in different organic fertilizers namely VAM, Panchagavya, *Azospirillum* and mixture of the three fertilizers. Control was maintained without any fertilizer. The study showed maximum germination in T_4 ie., VAM+Panchagavya+*Azospirillum*(Table 1).

Shoot Length

The shoot length of the groundnut plants at different stages of growth were measured and tabulated (Table 2). The growth was measured upto 75 days.

On the 30th day, the shoot length was more in T_3 ie., plants treated with *Azospirillum* (15.07 ± 1.01 cm). On the 45th, 60th and 75th day, the shoot length was higher in plants treated with the mixture of organic fertilizers (T_4) and the values were found to be 28.93 ± 0.31 cm, 28.17 ± 0.38 cm and 45.03 ± 0.15 cm respectively (Plate 1 to 4).

Root Length

The root length of the groundnut plants in control and other organic fertilizer treated plants were measured and tabulated (Table 3). The root length on the 30th day and 45th day was more in T_4 and values were 7.07 ± 1.01 cm and 11.53 ± 0.25 cm respectively. On the 60th day, the root length was higher in

T_1 (11.83 ± 0.76 cm) and on the 75th day, it was more in T_4 (15.20 ± 0.20 cm).

Various types of material can be used as carrier for seed or soil inoculation. The properties of a good carrier material for seed inoculation are inexpensive and available in adequate amounts (Mohammadi and Soharbi, 2012). Nitrogen is one of the majorimportant

Table 1 Germination percentage of *Arachis hypogeae* L.

Treatments	Percentage
T_0	60
T_1	40
T_2	70
T_3	80
T_4	**90**

Table 2 Shoot length (cm) of *Arachis hypogeae* L. at different stages of growth

Treatments	30th day	45th day	60th day	75th day
T_0	15.03 ± 0.95	20.50 ± 0.50	23.67 ± 0.58	37.23 ± 0.25
T_1	14.33 ± 1.53	19.50 ± 0.50	25.93± 0.31	33.30 ± 0.26
T_2	12.57 ± 0.60	21.00 ± 1.00	27.17± 0.76	33.23 ± 0.25
T_3	**15.07 ± 1.01**	22.83 ± 0.29	24.87± 0.81	35.33±0.25
T_4	12.17 ± 1.04	**28.93 ± 0.31**	**28.17± 0.38**	**45.03±0.15**
SEd	0.8715	0.4728	0.4908	0.2715
CDP<0.05)	1.9419	1.0535	1.0936	0.6052

Values are given as mean ± SD from 3 samples in each group

Plate 1 Growth of *Arachis hypogeae* L. on the 30th day

Plate 2 Growth of *Arachis hypogeae* L. on the 45th day

Plate 3 Growth of *Arachis hypogeae* L. on the 60th day

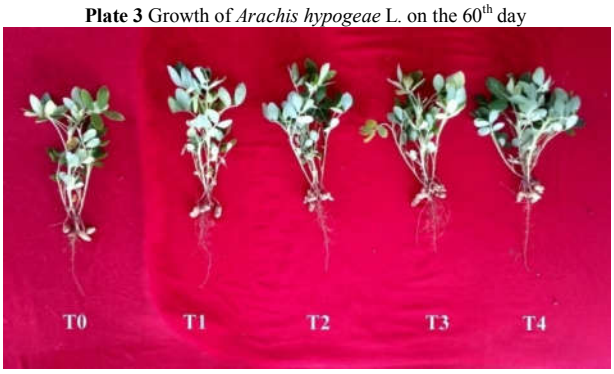

Plate 4 Growth of *Arachis hypogeae* L. on the 75th day

Table 3 Root length (cm) of *Arachis hypogeae* L. at different stages of growth

Treatments	30th day	45th day	60th day	75th day
T_0	5.00 ± 1.00	4.93 ± 0.40	6.53 ± 0.50	4.43 ±0.21
T_1	5.00 ± 1.00	7.13 ± 0.31	**11.83 ± 0.76**	10.20 ±0.20
T_2	7.00 ± 1.00	9.50 ± 0.50	9.43 ± 0.40	13.40 ±0.53
T_3	4.00 ± 1.00	5.17 ± 0.76	9.47 ± 0.06	10.43 ±0.51
T_4	**7.07 ± 1.01**	**11.53 ± 0.25**	7.40 ± 0.26	**15.20 ±0.20**
SEd	0.8176	0.3921	0.3783	0.2981
CD(P<0.05)	1.8217	0.8738	0.8429	0.6643

Values are given as mean ± SD from 3 samples in each group

Nutrient very much essential for crop growth. Atmosphere contains about 80% of nitrogen volume in free state.

Earlier studies by Aseri *et al*. (2008) have shown a significant increase in nutrient uptake by pomegranate upon inoculation with various beneficial microorganisms. Their studies have also shown that, dual inoculation could lead to a maximum uptake of N, P, K, Ca and Mg and micronutrients in pomegranate seedlings. Their results showed a significant enhancement in plant height, plant canopy, pruned plant material and fruit with a maximum increase in dual inoculation treatment.

Fresh Weight

The fresh weight of the groundnut plants grown under control and different organic fertilizers were calculated and tabulated (Table 4). On the 30th and 75th day, the fresh weight was more in plants treated with *Azospirillum* and the values obtained were 9.68 ±0.73 g and 43.70 ± 0.85 g respectively. On the 45th day and 60th day, the fresh weight calculated were found to be higher in plants treated with the combination of fertilizers ie., VAM + Panchagavya + *Azospirillum* and the readings were observed to be 15.53 ± 0.55 g and 33.60 ± 0.20 g respectively.

Dry Weight

The dry weight of the uprooted groundnut plants was measured after drying the plants in Hot air oven and tabulated (Table 5). The dry weight correlated with the fresh weight of the plants and it was observed to be more in T_3 on the 30th day (0.91 ± 0.25 g) and 75th day (8.25 ± 1.01 g). On the 45th day and 60th day, the dry weight of the plants was found to be more in T_4 and the values were 3.13 ± 0.03 g and 5.01 ± 0.19 g respectively.

Table 4 Fresh weight (g) of *Arachis hypogeae* L. at different stages of growth

Treatments	30th day	45th day	60th day	75th day
T_0	3.23 ± 1.07	7.54 ± 0.19	24.47 ± 0.15	22.33±0.49
T_1	5.58 ± 0.52	10.54 ± 0.29	24.43 ± 0.15	32.27±0.81
T_2	3.50 ± 0.56	6.57 ± 0.21	20.30 ± 0.26	34.00±1.05
T_3	**9.68 ± 0.73**	12.60 ± 0.26	30.47 ± 0.84	**43.70±0.85**
T_4	4.63 ± 0.40	**15.53 ± 0.55**	**33.60 ± 0.20**	22.57±0.67
SEd	0.5692	0.2677	0.3386	0.6512
CD(P<0.05)	1.2682	0.5965	0.7545	1.4509

Values are given as mean ± SD from 3 samples in each group

Table 5 Dry weight (g) of *Arachis hypogeae* L. at different stages of growth

Treatments	30th day	45th day	60th day	75th day
T_0	0.23 ± 0.10	1.43 ± 0.60	2.68 ± 0.38	3.56±0.41
T_1	0.41 ± 0.17	2.03 ± 0.06	4.05 ± 0.09	5.50±0.66
T_2	0.59 ± 0.07	0.94 ± 0.29	4.01 ± 0.13	7.29±0.61
T_3	**0.91 ± 0.25**	2.30 ±0.52	2.45 ± 0.43	**8.25±1.01**
T_4	0.31 ± 0.15	**3.13 ±0.03**	**5.01 ± 0.19**	4.76±0.85
SEd	0.1326	0.3089	0.2295	0.6005
CD(P<0.05)	0.2954	0.6882	0.514	1.3381

Values are given as mean ± SD from 3 samples in each group

Number of Leaves

The number of leaves present in the test crop during different days of growth was counted and tabulated (Table 6). The number of leaves were found to be more in T_3 on the 30th day (10.67 ± 0.58), 45th day (14.67 ± 0.56) and 75th day (28.00 ± 1.00). On the 60th day, the number of leaves was more in T_4 (24.67 ± 0.58).

Girth of the Stem

The girth of the groundnut plants also showed variations due to organic fertilizer treatments. The girth of the stem was measured on the 45th day, 60th day and 75th day and tabulated (Table 7). The girth was more in T_4 on the 45th day (1.77 ± 0.15 cm) and 60th day (2.10 ± 0.36 cm). On the 75th day of growth, the girth was more in T_1 (1.77 ± 0.06 cm).

Yield Parameter

Number of Pods

The number of pods produced by the groundnut was calculated to analyze the yield parameter. The number of pods was more in the plants treated with *Azospirillum* on the 60th day (8.33 ± 0.58) as well as 75th day (18.67 ± 0.58). The values were tabulated (Table 8)

Most of the leguminous crop plants have symbiotic relationship with root nodule rhizobacteria called *Rhizobia* (Singh *et al*., 2016). Soil fertility status and soil microclimate also affect the rate of interaction, nodulation as well as amount of N fixation.

Studies carried out by Mounika *et al*. (2018) on the influence of bio-fertilizers and micronutrients on seed yield, essential oil and oleoresins of coriander have inferred that the combination of seed inoculation with *Azospirillum* + Phosphate solubilizing bacteria and foliar application of $ZnSO_4$ at 5% showed a beneficial effect on the yield and yield attributing parameters of coriander.

Kumar *et al*. (2011) have studied the growth and development of black gram under foliar application of panchagavya as an organic source of nutrient and proved that the foliar spray at different intervals recorded significantly higher growth and yield of black gram than NPK and untreated control.

Table 6 Number of leaves in *Arachis hypogeae* L. at different stages of growth

Treatments	30th day	45th day	60th day	75th day
T_0	6.67 ± 0.59	8.67 ± 0.58	17.00 ± 1.00	23.33±0.51
T_1	10.33 ± 0.56	9.00 ± 0.00	23.33 ± 0.50	26.33±0.56
T_2	5.67 ± 0.48	6.67 ± 0.52	18.67 ± 0.58	25.33±0.58
T_3	**10.67 ± 0.58**	**14.67 ± 0.56**	20.67 ± 0.56	**28.00±1.00**
T_4	6.67 ± 0.53	10.33 ± 0.54	**24.67 ± 0.58**	15.00±1.01
SEd	0.4714	0.4216	0.5578	0.6325
CD(P<0.05)	1.0504	0.9395	1.2428	1.4092

Values are given as mean ± SD from 3 samples in each group

Table 7 Girth (cm) of the stem of *Arachis hypogeae* L. at different stages of growth

Treatments	45th day	60th day	75th day
T0	1.17±0.15	1.43 ± 0.21	0.97±0.15
T1	1.48±0.21	1.57 ± 0.06	1.77±0.06
T2	1.00±0.10	1.43 ± 0.12	1.40±0.10
T3	1.17±0.15	1.83 ± 0.06	1.20±0.12
T4	1.77±0.15	2.10 ± 0.36	1.13±0.12
SEd	0.1700	0.1606	0.0816
CD(P<0.05)	0.3787	0.3577	0.1819

Values are given as mean ± SD from 3 samples in each group

Table 8 Number of pods in *Arachis hypogeae* L. on the 60th and 75th day

Treatments	60th day	75th day
T_0	5.67 ± 0.58	7.33±0.58
T_1	8.00 ± 1.00	7.00±0.00
T_2	2.67 ± 0.58	7.67±0.58
T_3	**8.33 ± 0.58**	**18.67±0.58**
T_4	**8.33 ± 0.58**	14.67±0.58
SEd	0.5578	0.4216
CD(P<0.05)	1.2428	0.9395

Values are given as mean ± SD from 3 samples in each group

Nodulation in *Arachis hypogeae* L.

The number of nodules formed in *Arachis* was calculated on the 30th, 45th, 60th and 75th day. Since, *Arachis* is a leguminous crop, it forms symbiotic association with the soil bacteria and forms root nodules. These nodules help the plant to fix the atmospheric nitrogen. The nodules formed were calculated and tabulated (Table 9).

Table 9 Number of nodules in *Arachis hypogeae* L. at different stages of growth

Treatments	30th Day	45th Day	60th Day	75th Day
T_0	1.67 ± 1.15	6.67±2.08	53.33±4.93	93.33±6.51
T_1	7.67 ±1.53	12.00±2.65	77.67±3.06	102.33±5.86
T_2	16.67 ±3.06	18.67±3.06	**98.00±3.00**	**156.00±9.54**
T_3	**23.00 ±2.65**	**26.00±2.00**	49.67±4.04	82.00±7.00
T_4	15.00 ±2.65	25.00±3.61	51.67±3.06	89.33±3.21
SEd	1.8974	2.2410	3.0185	5.5015
CD(P<0.05)	4.2276	4.9934	6.7256	12.2582

Values are given as mean ± SD from 3 samples in each group

The root nodules started forming on the 30th day of growth itself. In plants treated with *Azospirillum*, more nodules were formed on the 30th day and 45th day and the values were 23.00 ± 2.65 and 26.00 ± 2.00. On the 60th day and 75th day, the nodule formation was very high in plants treated with panchagavya. This shows that the plant could utilize the available nutrient source and grow well when treated with panchagavya in the later stages.

Earlier studies by Sangeetha and Thevanathan (2010) have shown that panchagavya, a vedic formulation increases the productivity and disease resistance in plants when amended with seaweed extract.

Studies by Shete *et al*. (2018) have shown that foliar spray of bio-fertilizers significiantly increased the growth and nutrient uptake of Kharif Groundnut. The present result on the increase in growth parameters of groundnut due to use of Bio-fertilizers is on par with the earlier studies.Groundnut seeds are a rich source of protein, sugars and oil. Earlier studies by Shad *et al*. (2009) have proved its higher calorific score as compared to most of the other legumes.

On the basis of the results obtained and the discussion made so far, it may be concluded that application of the organic fertilizer orbio-fertilizer is the most effective way for higher growth and yield of the crop plant studied. Hence,the microbial fertilizers hold a vast potential for future use of and management of natural resource in sustainable agriculture.The conclusion is based on only pot culture experiments. Further studies in the field are required to strongly support the current investigation.

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