International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2018; 6(5): 1061-1064

Received: 07-07-2018
Accepted: 08-08-2018

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Effect of liquid biofertilizer on growth and yield of summer groundnut (*Arachis hypogea* L)

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Abstract
Present investigation was carried out at AICRP on groundnut, Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist. Ahmednagar (Maharashtra). The experiment was laid out in factorial randomized block design with three replications. The treatments consisted of three levels of recommended dose of fertilizers viz., 100%, 75% and 50%. and biofertilizers viz., *rhizobium* (liquid) *rhizobium* (solid), phosphorus solubilizing bacteria, and control.
The *rhizobium* (liquid) significantly increased the growth attributes viz., plant height, primary branches plant^{-1} and secondary branches plant^{-1} resulting in significant increase in groundnut yield (5540.33 kg ha^{-1}) due to treatment *rhizobium* (liquid) as compared to control (4556.00 kg ha^{-1}). The important phenological studies in respect of days required for initiation of flowering, was significantly influenced under treatments *rhizobium*, PSB, over control suggesting suitability of *rhizobium* for cultivation of groundnut. The 100% RDF recorded significantly higher yield of groundnut (5423.00 kg ha^{-1}) over 75% and 50% RDF. Based on one year of experimentation, it could be concluded that the growing of RHRG-6021 variety of groundnut under inoculation of *rhizobium* (liquid) with 100% RDF found significantly superior for higher yield during summer season.

Keywords: Groundnut, biofertilizers, *Rhizobium*, and yield

Introduction
Groundnut (*Arachis hypogaea* L) is the fore most important oil seed crop of India, in terms of area and production. It occupies an important position among the oilseed crops in the world. India which adopt groundnut crop by late nineteenth century, gradually became the major groundnut producing country in the world within a span of 5-6 decades, groundnut is known to be unique and important oilseed crop of India. Groundnut (*Arachis hypogaea* L) a member of family leguminaceae, is also known by the name peanut, goober peas, earthnuts, pindas, jack nuts, pinders, manila nuts, and monkey nuts. The botanical name of groundnut is the *Arachis hypogaea* L. meaning underground, referring to formation of pod in the soil. The origin of groundnut is Central America. It is an essential and can be grown under tropical and subtropical climatic conditions; it is grown under mean temperature between 25-28 ^{0}C. It is grows well in region where 500-1200 mm annual rainfall is received. Edible oils and fats have an important place in our diet. Groundnut is also recognized as poor man's nut. Groundnut kernels are rich in proteins and vitamins viz., A, B, B1, k. Kernels are consumed raw, roasted, salted or sweetened. The reducing sugars in groundnut are low (1.2 to 1.8 per cent). Sucrose is the most important sugar, which ranges between 2.86 to 6.35 per cent. Glucose, fructose and galactose are the other minor sugars present. It is rich source of minerals like phosphorus, calcium, magnesium, potassium, zinc, copper, iron and manganese (Nagraj, 1995) [5]. About 200 g of groundnut can easily furnish recommended dietary allowance of minerals as prescribed by FAO. Inoculation of groundnut with efficient competitive rhizobia was considered as a beneficial practice since the native rhizobia were not able to supply the total nitrogen requirements of groundnut (Hadad *et al.*, 1986) [2]. Similarly, the low yield of groundnut in India was suggested to be due to low nodulation and to comptetition from indigenous ineffective strains (Basu and Bhadoria, 2008) [1]. While utilize Bio-fertilizers importing a large population of effective microorganisms in the active field of root system, increase plants power to absorb more nutrients (khavazi *et al.*, 2005) [3].
Rhizobactries as a part of a global management system reduce use of synthetic compounds and chemical fertilizers and provides sustainable agriculture (Muhammad *et al*., 2008) [4].

Production of *rhizobium* inoculums types of biological fertilizers, especially in developed countries and developing countries are carried out with different motivations.

Bio-fertilizers can play an important role in meeting the nutrient requirement of crops through biological nitrogen fixation (BNF), solubilization of insoluble phosphorus sources (PSB), extend the nutrient absorption to zones not accessible to plant roots (VAM). Therefore introduction of efficient strain of *rhizobium* in the soil which is poor in nitrogen may be helpful in boosting up production and consequently more nitrogen fixation. Several bacteria belonging to genera Pseudomonas and Bacillus have the ability to solubilize inorganic phosphorus insoluble sources. Inoculation of seed with phosphate solubilizing bacteria (PSB) increases crop growth, nutrient availability, uptake and crop yield.

Materials and meth

A field experiment on groundnut was conducted at AICRP on groundnut. Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist. Ahmednagar. The present investigation was undertaken during the *Kharif* season. The experiment was laid out in factorial randomized block design with three replications. The treatment consisted of *rhizobium* (liquid) *rhizobium* (solid), phosphorus solubilizing bacteria, and control, with 100, 75, and 50 per cent RDF with variety. RHRG-6021. The soil of the experimental field was black sandy in texture with moderate in available nitrogen (280.32 kg ha^{-1}), high in available phosphorous (32.55 kg ha^{-1}) and very high in available potassium (362.25 kg ha^{-1}) with slightly alkaline in reaction (PH 7.75). The electrical conductivity of soil was 0.28dSm-1 and organic carbon content was 0.55%. The initial values of the field capacity, permanent wilting point and bulk density were 25.45%, 13.17% and 1.41 g cm^{-3}, respectively. The seeds were sown on15th March, 2014 at spacing of 30 cm × 10 cm. The irrigation was given at whenever necessary. The recommended cultural operations and plant protection measures were carried out timely.

Results and discussion

1. Periodical mean plant height per plant (cm)

A. Effect of biofertilizers

At 90 DAS, the differences in the mean plant height due to various treatments were statistically significant. The treatment *rhizobium* (liquid) recorded the significantly highest plant height (16.26cm). Followed by *rhizobium* (solid) (16.02cm) and phosphorus solubilizing bacteria (14.96cm) were significantly superior over the control (14.72cm).

B. Effect of fertilizer

The plant height was influenced significantly due to different levels of fertilizers at 90 DAS. The 100% RDF exhibited significantly higher plant height (16.78cm) as compared to 75% and 50% RDF.

C. Effect of Interaction

The interaction effect of biofertizers and fertilizers on plant height of groundnut were found significant at 90 DAS. It was observed that the interaction of treatment *rhizobium* (liquid) and 100% RDF recorded the significantly highest plant height (18.10cm) over rest of combinations.

2. Periodical mean number of primary branches per plant

A. Effect of biofertilizers

At 90 DAS, the treatment *rhizobium* (liquid) recorded the significantly highest number of primary branches (8.32) $plant^{-1}$, followed by *rhizobium* (solid) (8.23) and phosphorus solubilizing bacteria (8.01) were significantly superior over the control (7.07).

B. Effect of fertilizer

The number of primary branches $plant^{-1}$ was influenced significantly due to different levels of fertilizers at 90 DAS. The 100% RDF exhibited significantly higher number of primary branches (7.41), (7.82) $plant^{-1}$ as compared to 50% RDF.

C. Effect of Interaction

The interaction effect of biofertizers and fertilizers on number of primary branches $plant^{-1}$ of groundnut were found significant at 90 DAS. Interaction effect of biofertilizers and fertilizers on number of primary branches $plant^{-1}$ at 90 DAS found statistically significant. It was observed that interaction of *rhizobium* (liquid) and 100% RDF recorded the significantly highest number of primary branches (9.84) plant-1 followed by *rhizobium* (solid) and phosphorus solubilizing bacteria over 50% RDF.

3. Periodical mean number of secondary branches per plant

A. Effect of biofertilizers

At 90 DAS, the differences in the mean number of secondary branches $plant^{-1}$ due to various treatments were statistically significant. The treatment *rhizobium* (liquid) recorded the highest number of secondary branches (9.08) $plant^{-1}$ followed by treatments *rhizobium* (solid) (8.79) and phosphorus solubilizing bacteria (8.61) over control (7.30).

B. Effect of fertilizer

The number of secondary branches $plant^{-1}$ was influenced significantly due to different levels of fertilizers. The 100% RDF exhibited significantly higher number of secondary branches (10.51) plant-1 as compared to 75% (9.51) and 50% RDF (9.37) at 90 DAS

C. Effect of Interaction

Interaction effect of biofertilizers and fertilizers on number of secondary branches $plant^{-1}$ at 90 DAS (table.10) found statistically significant. It was observed that interaction of *rhizobium* (liquid) and 100% RDF recorded the significantly highest number of secondary branches (13.70) $plant^{-1}$ followed by *rhizobium* (solid) and phosphorus solubilizing bacteria over rest of combinations.

4. Mean number of days required for Initiation of flowering.

A. Effect of biofertilizers

The differences in the number of days required for initiation of flowering due to different treatments were statistically significant. The treatment *rhizobium* (liquid) recorded the minimum number of days for initiation of flowering (26.93) flowering followed by *rhizobium* (solid) (28.12) phosphorus solubilizing bacteria (29.16).whereas control required higher number of days (30.53) for initiation of flowering.

B. Effect of fertilizer

The number of days for initiation of flowering was influenced significantly due to different levels of fertilizers. The 100% RDF requires minimum number of days (38.23) for initiation of flowering compared to 75% and 50% RDF.

C. Effect of Interaction

The interaction effect of different biofertilizers and fertilizers was found to be significant in respect of days required for initiation of flowering, 50% flowering and days to maturity.

5. Mean dry pod yield kg ha^{-1}

A. Effect of biofertilizers

The differences in respect of dry pod yield kg ha^{-1} due to various treatments were statistically significant. The treatment *rhizobium* (liquid) (recorded the highest dry pod yield 5540.33 kg ha^{-1} followed by *rhizobium* (solid) (5369.03 kg ha-1) and PSB (4862.66 kg ha-1).

B. Effect of fertilizer

The dry pod yield kg ha^{-1} was influenced significantly due to different levels of fertilizers. The 100% RDF exhibited significantly higher dry pod yield (5423.00 kg ha^{-1}) followed by 75% (5142.75kg ha^{-1}) over 50% RDF.

C. Effect of Interaction

The interaction effect of different biofertilizers and fertilizers was found to be significant in respect of dry pod yield kg ha^{-1} in groundnut. It was observed that interaction of rhizobium (liquid) and 100%RDF recorded the significantly highest dry weight of pod $plant^{-1}$ (27.79g) followed by rhizobium (solid) and phosphorus solubilising bacteria over rest of combinations.

Table 1: Effect of liquid biofertilizer on Plant height, Primary branches, Secondary branches, Days required for initiation of flowering and dry pod yield (Kg ha^{-1}) of Groundnut.

Treatment	Plant height (cm)	Primary branches	Secondary branches	Days required for initiation of flowering	Dry pod yield (Kg ha^{-1})
Biofertilizer (B)					
Control (B1)	14.72	7.07	7.30	30.53	4556.00
Rhizobium (liquid) (B2)	16.26	8.32	9.08	26.93	5540.33
Rhizobium (Solid) (B3)	16.02	8.23	8.79	28.12	5369.03
PSB (B4)	14.96	8.01	8.61	29.16	4862.66
S.Em. ±	0.07	0.02	0.10	0.214	58.40
C.D. at 5%	0.22	0.08	0.29	0.629	171.30
Fertilizer (F)					
100% RDF (F1)	16.78	7.82	10.51	26.82	5423.00
75% RDF (F2)	15.74	7.64	9.51	29.44	5142.75
50% RDF (F3)	14.94	7.33	9.37	29.79	4552.52
S.Em. ±	0.21	0.07	0.27	0.594	161.72
C.D. at 5%	0.63	0.22	0.81	1.714	474.32
Interaction (B x F)					
S.Em. ±	0.43	0.15	0.55	1.187	323.45
C.D. at 5%	1.26	0.45	1.63	3.482	808.55
General mean	15.63	7.77	9.02	28.68	5039.41

Table 2: Interaction effect of biofertilizer and fertilizer on plant height at 90 DAS.

	Biofertilizer (B)			
Fertilizer (F)	**Control(B1)**	***Rhizobium* (liquid) (B2)**	***Rhizobium* (solid) (B3)**	**Phosphorus solubilizing bacteria (B4)**
100% RDF - F1	13.14	18.10	17.95	15.88
75% RDF - F2	13.10	17.78	15.03	13.95
50% RDF - F3	11.24	13.85	13.24	12.80
S.Em. ±	0.43			
C.D. at 5%	1.26			

Table 3: Interaction effect of biofertilizer and fertilizer on number of primary branches per plant at 90 DAS.

	Biofertilizer (B)			
Fertilizer (F)	**Control(B1)**	***Rhizobium* (liquid) (B2)**	***Rhizobium* (solid) (B3)**	**Phosphorus solubilizing bacteria (B4)**
100% RDF - F1	8.54	9.84	9.66	9.40
75% RDF - F2	7.50	8.52	7.78	7.64
50% RDF - F3	6.08	7.44	7.24	6.60
S.Em. ±	0.15			
C.D. at 5%	0.45			

Table 4: Interaction effect of biofertilizer and fertilizer on number of secondary branches per plant at 90 DAS.

	Biofertilizer (B)			
Fertilizer (F)	**Control(B1)**	***Rhizobium* (liquid) (B2)**	***Rhizobium* (solid) (B3)**	**Phosphorus solubilizing bacteria (B4)**
100% RDF - F1	7.76	13.70	11.66	9.62
75% RDF - F2	5.41	13.37	11.14	6.75
50% RDF - F3	4.56	6.25	5.59	5.35
S.Em. ±	0.65			
C.D. at 5%	1.63			

Table 5: Interaction effect of biofertilizer and fertilizer on days required for initiation of flowering.

	Biofertilizer (B)			
Fertilizer (F)	**Control(B1)**	***Rhizobium* (liquid) (B2)**	***Rhizobium* (solid) (B3)**	**Phosphorus solubilizing bacteria (B4)**
100% RDF - F1	28.39	24.00	26.00	27.00
75% RDF - F2	31.00	26.42	28.95	29.95
50% RDF - F3	31.43	29.95	28.39	30.98
S.Em. ±	1.18			
C.D. at 5%	3.48			

Table 6: Interaction effect of biofertilizer and fertilizer on dry pod yield kg ha^{-1}.

	Biofertilizer (B)			
Fertilizer (F)	**Control(B1)**	***Rhizobium* (liquid) (B2)**	***Rhizobium* (solid) (B3)**	**Phosphorus solubilizing bacteria (B4)**
100% RDF - F1	5212.00	5960.00	5671.00	5497.00
75% RDF - F2	4343.00	5412.00	5033.00	4687.00
50% RDF - F3	3966.00	4990.00	4190.00	4166.00
S.Em. ±	323.45			
C.D. at 5%	808.55			

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