



Effect of Phosphorus Solubilizing Bacteria and Potassium Mobilizing Bacteria on growth and yield of Groundnut (*Arachis hypogea*)

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(Received: 26 July 2025; Revised: 25 August 2025; Accepted: 24 September 2025; Published online: 08 October 2025)

(Published by Research Trend)

DOI: <https://doi.org/10.65041/BF.2025.17.10.7>

ABSTRACT: Fifteen root and rhizospheric soil samples were collected from different villages of Kolhapur district. Isolation was carried out on Pikovaskays medium for PSB and Aleksandrov's medium medium for KSB. Out of eight isolates, four of phosphorus solubilizing bacteria (PSB) and remaining four of Potassium mobilizing bacteria (KMB) were obtained. All the obtained isolates of PSB and KMB were identified on the basis of morphological and biochemical tests. Efficient strain of PSB (PSB -2) and KMB (KMB-2) used for field experiment. The treatment T₁₁, Commercial strain of PSB and KMB+RDF showed the highest growth parameters viz. Plant height, No. of branches per plant which was at par with the treatment T₉, PSB+KMB+R.D. of N +75% P₂O₅ and K₂O. The results concern yield parameters revealed that the treatment T₁₁, Commercial strain of PSB and KMB+RDF showed the highest grain weight (44.63 g), pod yield (43.56 q/ha) and dry matter yield (24.81 kg/ha) which was on part with T₉, PSB and KMB +RDF of N+75% P₂O₅ and K₂O i.e. grain wt. (43.61g), pod yield (43.30 q/ha) and dry matter yield (24.81 kg/ha) and uptake of nitrogen phosphorus and Potassium by groundnut plant also found to be increased 120.00 kg h and 37.00kg/ha respectively. Considering this, it seems that use of PSB and KMB along with 75% recommended dose of P₂O₅ and K₂O may be a better combination for sustainable groundnut production.

Keywords: Phosphorus Solubilizing Bacteria and Potassium Mobilizing Bacteria, *Arachis hypogea*, rhizospheric soil.

INTRODUCTION

Biofertilizers play an important role in increasing nutrient availability to crop plants. They are environmentally, cost effective and ecofriendly sustainable source. Biofertilizers, as opposed to chemical fertilizers, support long-term soil health, enhance the soil's physical, chemical, and biological properties, and lessen their negative environmental effects (Pahalvi *et al.*, 2021). Similarly, biofertilizers also enhance soil chemical properties by promoting the nitrogen fixation process (Chaurasia *et al.*, 2024a). Furthermore, by dissolving insoluble phosphates, phosphorus-solubilizing bacteria in biofertilizers increases phosphorus availability (Arif *et al.* 2017). Groundnut is an important oilseed crop in India occupying first position in terms of area and second in terms of production after soybean. In India, Groundnut is considered the "king of oilseeds". This oil seed crop is primarily found in tropical and subtropical regions, and is also known as peanut, earthnut, monkey nut and poor men's cashew nut. The global

area, production and productivity of groundnut is 29.7 million ha, 50.8 million tonnes and 17.1 quintal ha⁻¹, respectively. China is the world's largest producer of groundnut with 4.6 million ha area, 17 million tonnes production and productivity of 37.0 quintal ha⁻¹ followed by India. Groundnut covers an area of 4.8 million ha with production of 9.9 million tonnes and productivity of 20.6 quintal ha⁻¹ in India during 2019 -20 (Anonymous, 2020). It plays a major role in bridging the vegetable oil deficit in the country. Groundnuts provide essential nutrients to the human body, in the form of proteins, carbohydrates, fats, vitamins, minerals and fiber. Groundnut is great and economical source of nourishment. In the prevention of diseases or some immune-based disorders in human can be prevented by the consumption of protein-rich foods like groundnut which provides energy-rich nutrients and bioactive compounds which regulates the human immune system.

In groundnut P, K and N is vital for plant growth and yield parameters. Phosphorus is considered a crucial mineral fertilizer for the flourishing production of the

crop (Hasan *et al.*, 2021). The requirement of phosphorus in nodulating legumes is higher as compared to non-nodulating crop as it plays significant role in nodule formation and fixation of atmospheric nitrogen (Brady & Well 2002). Phosphorus determines plant reproductive efficiency and plays a vital role in growth and development of groundnut crop (Savani & Sarji 1995). Legumes often need phosphorus for good seed formation (Asiedu *et al.*, 2000). So, the PSB is more important which solubilize phosphorous by secreting organic acids. These acids lower the pH & bring dissolution of bound phosphate (Subba Rao, 1993). Another important element is Potassium which is considered one of the primary nutrients responsible for quality of ground nut crop. Also adequate potassium supply is essential for proper pod development, kernel filling and maintaining high oil quality (Sanadi *et al.*, 2008). KMB is very important which convert the insoluble or mineral structure K compounds into soluble form in soil as a soil solution and make them available to plants (Zeng *et al.*, 2012). KMB are effective in releasing K from inorganic and insoluble pools of total soil K through solubilization (Archana *et al.*, 2013, Meena *et al.*, 2015, Saha *et al.*, 2016). The inoculation with KMB produced beneficial effect on growth of different plants (Ahmad *et al.*, 2016, Bakhshandeh *et al.*, 2017). Furthermore, by introducing a range of advantageous microorganisms such as nitrogen-fixing bacteria and fungi biofertilizers increase microbial diversity and foster a more resilient and dynamic soil microbiome (Odoh *et al.*, 2020). By promoting disease resistance in plants, improved nutrient cycling, and healthy soil, this all-encompassing strategy supports sustainable agricultural methods (Ghimirey *et al.*, 2024c).

Hence good balance between chemical and biological fertilizers should be used to achieve both quality and quantity in groundnut production. The present investigation was designed and results were put forth.

MATERIALS AND METHODS

A field experiment was conducted at Rajarshree Chhatrapati Shahu Maharaj Collge of Agriculture, Kolhapur (Maharashtra, India) during the summer season of the year 2023. Seeds of Phule Unnati variety was treated with lignite based powder formulation of efficient bacterial inoculum of PSB and KMB @ 250 g per 10 kg seeds. During seed treatment, 10% jaggery solution was used as an adhesive. Chemical fertilizers were applied, as per the treatments. The cultural operation like irrigation, weeding were uniformly carried out to all the treatments. All the data obtained was statistically analyzed by using the Panse and Sukhathe (1985) procedure.

RESULT AND DISCUSSION

Fifteen root and rhizospheric soil samples were collected from different villages of Kolhapur district. Isolation was carried out on Pikovaskays medium for

PSB and Aleksandrov's medium medium for KSB. Out of eight isolates, four of phosphorus solubilizing bacteria (PSB) and remaining four of potash mobilizing bacteria (KMB) were obtained. All the obtained isolates of PSB and KMB were identified on the basis of morphological and biochemical tests. Efficient strain of PSB (PSB-2) and KMB (KMB-2) used for field experiment.

A. Effect on growth parameter

Plant height and branches per plant were recorded after 90 days are presented in Table 1. The results indicated that the treatment T₁₁, Commercial strain of PSB and KMB + RDF observed highest plant height (38.90 cm) at par with T₉, PSB + KMB + R.D. of N + 75% P₂O₅ and K₂O (37.68cm). Lowest plant height was observed in T₁, PSB (27.16 cm).

This might be due to adequate supply of nutrients required for optimum growth and development of groundnut plants under different treatments. This finding is in agreement with that of Tsegaye (2022) and Ghosh *et al.* (2022). The nitrogen helps the cells of the apical meristem to enlarge. Apical meristem helps in shoot growth which affects plant growth. Microbial secretion of organic acid might help in improving soil condition required for better root proliferation. Better availability of nutrients like nitrogen, phosphorous and potassium at early stages helped for synthesis of biomolecules, protein metabolism leading to more plant height (Chaudhary *et al.*, 2019) & similar results were found by Singh *et al.* (2002) in soyabean. This finding is in agreement with that of Tsegaye (2022) and Ghosh *et al.* (2022).

The result about no. of branches specified that treatment T₁₁, Commercial strain of PSB and KMB+RDF showed maximum (22.40) branches per plant which was statistically found at par with treatment T₉, PSB + KMB + R.D. of N+75% P₂O₅ and K₂O (21.68), T₁₀ PSB + KMB + R.D. of N+50% P₂O₅ and K₂O (21.68) and T₇, PSB + RDF (21.58). This results shows similarity with Singh (2007) in soyabean crop increases in branches per plant up to 16.

B. Yield characters

Number of pods per plant. Results revealed that treatment T₁₁, Commercial strain of PSB and KMB + RDF showed maximum pods number per plant (43.56) which was statistically found at par with treatment T₉, PSB + KMB +R.D. of N + 75% P₂O₅ and K₂O (42.30). This might be due to improvement in vegetative structures for nutrient absorption and photosynthesis as a result of KSB and other microorganisms application. This finding conforms with the Kamboj *et al.* (2023) which reported increased matured pod yield in groundnut due to P application (Chaudhary *et al.*, 2019). This results were found similarity with Sagervanshi *et al.* (2014) in soyabean, Parmar *et al.* (2016) who observed 20% no. of pods per plant due to PSB application.

Table 1: Effect of Phosphate Solubilizing Bacteria and Potash Mobilizing Bacteria on growth and yield parameters.

Tr. No.	Treatment details	Per cent germination (%)	Plant height (cm)	No. of branches	No. of Pods per plant	Seed Index	Yield (q/ha)	Dry matter (g/plant)
T ₁	PSB	84.67	27.16	12.33	20.80	34.16	20.21	18.21
T ₂	KMB	81.70	28.18	11.51	13.75	32.36	16.92	15.87
T ₃	PSB + R.D. of N + 75% P ₂ O ₅ + R.D. of K ₂ O	87.57	31.96	14.57	23.79	39.42	22.73	19.27
T ₄	PSB + R.D. of N + 50% P ₂ O ₅ + R.D. of K ₂ O	84.06	30.86	17.60	29.80	35.73	19.60	17.56
T ₅	KSB + R.D. of N & P ₂ O ₅ + 75 % K ₂ O.	87.62	33.02	14.58	22.00	38.53	24.32	16.33
T ₆	KSB + R.D. of N & P ₂ O ₅ + 50% K ₂ O	86.18	34.32	18.40	32.00	33.78	27.90	17.66
T ₇	PSB+RDF	92.23	36.82	21.58	41.79	42.40	33.18	23.97
T ₈	KSB+RDF	88.87	34.63	16.18	23.60	40.84	29.31	19.66
T ₉	PSB+KSB+R.D. of N + 75 % P ₂ O ₅ & K ₂ O	93.27	37.68	21.68	42.30	43.61	35.12	24.02
T ₁₀	PSB + KSB + R. D. of N+ 50% P ₂ O ₅ & K ₂ O	88.15	29.95	21.68	36.00	36.28	25.45	18.32
T ₁₁	Commercial Strain of PSB & KSB + RDF	94.37	38.90	22.40	43.56	44.63	35.58	24.81
T ₁₂	Control +RDF	89.13	35.29	15.95	23.40	40.05	21.07	21.81
	SE ±	1.70	0.59	0.59	0.87	0.89	1.38	0.47
	CD	3.35	1.77	1.77	2.34	2.49	4.24	3.23

Dry matter of groundnut. Result revealed that treatment T₁₁, Commercial strain of PSB and KMB + RDF showed maximum dry matter (24.81g/plant) which was statistically found at par with T₉, PSB + KMB + R.D. of N +75% P₂O₅ and K₂O (24.02g/plant) and T₇, PSB + RDF (23.97 g/plant). The results in accordance with researcher by Singh *et al.* (2002) in faba bean, Dwivedi *et al.* (1999) in *vigna mungo*.

Yield. Result depicted in Table 1, revealed that treatment T₁₁, Commercial strain of PSB and KMB + RDF showed maximum groundnut yield (35.58 q/ha) statistically found at par with treatment T₉, PSB+KMB+ R.D. of N +75% P₂O₅ and K₂O (35.12q/ha). Lowest yield was observed in treatment. T₂, KMB (16.92 q/ha). This is might be the effect of micro organisms which solubilize the nutrient which helped for optimum growth higher yield (Chaudhary *et al.*, 2019). These results are in accordance with the finding of Dwivedi *et.al* (1999) in Soyabean, Bansal (2009) in Mungbean, Sulochanamma and Reddy (2007) in *vigna radiata*.

Effect of efficient Phosphate solubilizing bacteria (PSB) and Potash mobilizing bacteria (KMB) on available N, P, K of groundnut (Kg/ha)

The effect of efficient Phosphorus solubilizing bacteria (PSB) and potash mobilizing bacteria (KMB) on available N, P, K of groundnut. are presented in Table 2. The results specified that N, P, K of groundnut. of groundnut was increased significantly when seeds were treated with Phosphorus solubilizing bacteria (PSB) and potash mobilizing bacteria (KMB) biofertilizers.

The results stated that maximum available Nitrogen of groundnut was observed in treatment T₁₁, Commercial strain of PSB & KMB +RDF showed maximum available N of groundnut (163.07 kg /ha) which was Sid *et al.*,

statically found at par with treatments T₉, PSB + KMB+ R.D. of N + 75% P₂O₅ & K₂O R. D. of N (162.72 kg /ha) and treatment were T₇, PSB+RDF (161.07kg /ha). Lowest germination was observed in treatment T₂, KMB (131.07 kg/ha) while rest of the treatments exhibited available of groundnut in range of 133.80-160.90 kg/ha. The results stated that maximum available Phosphorus of groundnut. was observed in treatment T₁₁, Commercial strain of PSB & KMB + RDF showed maximum available Phosphorus of groundnut. (20.00 kg /ha) which was statically found at par with treatments T₉, PSB + KMB + R.D. of N + 75% P₂O₅ & K₂O R. D. of N (19.90 kg /ha) and treatment were T₅ KMB + 75% Potassium + Rec. Dose of N and P (19.20 kg /ha) T₇, PSB+RDF (18.99kg /ha) treatment T₆ KMB + R.D. of N & P₂O₅ + 50% K₂O (18.87kg/ha).

Lowest available Phosphorus was observed in treatment T₂, KMB (15.90 kg/ha), while rest of the treatments exhibited available Phosphorus of groundnut. in range of 16.76 to 17.90 kg/ha.

The results indicated that, maximum available Potassium of groundnut was observed in treatment T₁₁, Commercial strain of PSB & KMB +RDF showed maximum. available Potassium (260.99 kg /ha) which was statically found at par with treatments T₉, PSB + KMB + R.D. of N + 75% P₂O₅ & K₂O R. D. of N (259.87 kg /ha) and treatment were T₇, PSB + RDF Lowest germination was observed in treatment T₂, KMB (245.50 kg/ha) while rest of the treatments exhibited available of K groundnut. in range of 246.70 to 251.99 kg/ha Similar results were found by Singh *et al.* (2002) in groundnut and Dwivedi *et al.*, (1999) in faba bean. They found that increase in available N due to quick supply of available nutrients through fertilizers.

Table 2: Effect of efficient Phosphate solubilizing bacteria (PSB) and Potash mobilizing bacteria (KMB) on available N, P, K of groundnut (Kg/ha).

Tr. No.	Treatment details	N (Kg/ ha)	P (Kg/ ha)	K (Kg/ha)
T ₁	PSB	134.05	16.90	246.70
T ₂	KMB	131.07	15.91	245.50
T ₃	PSB + R.D. of N+75% P ₂ O ₅ + R.D. of K ₂ O	159.90	17.92	248.80
T ₄	PSB + R.D. of N+50% P ₂ O ₅ + R.D. of K ₂ O	133.80	16.83	247.70
T ₅	KSB +R.D. of N & P ₂ O ₅ + 75 % K ₂ O	157.90	19.24	248.43
T ₆	KSB +R.D. of N & P ₂ O ₅ + 50% K ₂ O	153.90	18.87	247.70
T ₇	PSB+RDF	161.07	18.99	258.70
T ₈	KSB+RDF	159.78	16.76	257.90
T ₉	PSB+KSB+R.D. of N +75 % P ₂ O ₅ & K ₂ O	162.72	19.90	259.87
T ₁₀	PSB + KSB + R. D of N+ 50% P ₂ O ₅ & K ₂ O	158.80	17.70	251.99
T ₁₁	Commercial Strain of PSB & KSB + RDF	163.07	20.74	260.99
T ₁₂	Control +RDF	160.90	17.76	256.60
	S.E. ±	4.52	0.53	1.83
	C.D.@5%	12.2	1.59	5.49

Results are in agreement with Claus and Berkeley (1986), he concluded that significant available N, P, K, was (165.07, 22.5, 262.77 kg/ha) respectively which is reported in soyabean. Ganesan and Gnanamanickam (1987) found increased 10% height in *Vigna mungo* when inoculated with 100% RDF with PSB as compared to other treatment. The results also show similarity with Rao and Savalgi (2017).

CONCLUSIONS

It can be inferred that from the foregoing results & discussion that significant increases in growth and yield attributes due to PSB and KMB along with chemical fertilizer may be better combination for sustainable groundnut production.

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How to cite this article: S.T. Sid, Sunita J. Waghmare, D.P. Deshmukh, R.A. Karande, M.S. Kamble & N.A. Musmade (2025). Effect of Phosphorus Solubilizing Bacteria and Potassium Mobilizing Bacteria on growth and yield of Groundnut (*Arachis hypogaea*). *Biological Forum*, 17(10): 43-47.