



# Effect of Integrated Use of Phosphorus Fertilizers and Biofertilizers on Growth and Yield of Groundnut (*Arachis hypogaea* L.)

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## Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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## ABSTRACT

The present study highlight the effect of integrated use of phosphorus fertilizers and biofertilizers on growth and yield of groundnut (*Arachis hypogaea* L.). A field experiment was conducted during *rabi*, 2022 Wetland farm, S.V. Agricultural College, ANGRAU, Tirupati, Andhra Pradesh. Eight treatments and three replications made up the field experiment's randomized block design. The combined application of biofertilizers and phosphorus fertilizers had a substantial impact on the yield and growth of the groundnut crop. Most of the growth parameters and yield attributes *viz.*, dry matter production, plant height, number of nodules plant<sup>-1</sup>, number of filled pods plant<sup>-1</sup>, number of ill-filled pods plant<sup>-1</sup> were numerically highest with application of 75% RDP + liquid PSB + AM (T<sub>8</sub>) and 100 pod weight, 100 kernel weight, shelling percentage were recorded non-significant. Pod yield and kernel yield were recorded significantly highest with 75% RDP + liquid PSB + AM (T<sub>8</sub>) followed by 100% RDP + liquid PSB (T<sub>3</sub>).

**Keywords:** Groundnut; phosphorus; liquid PSB; AM.

## 1. INTRODUCTION

“Groundnut (*Arachis hypogaea* L.) is one of the major oilseed crops originated in Brazil and mostly grown in many Asian countries. It fixes the atmospheric nitrogen of nearly 72–77% of its N amounting to 150–200 kg N ha<sup>-1</sup> in 106–119 days in the soil and ameliorates the soil fertility status. India ranks second in terms of production (10.2 million tonnes) as well as consumption (5627.94 tonnes) of groundnut in 6.09 million hectares of area and productivity of 988 kg ha<sup>-1</sup> and it accounts for nearly 20 per cent of world's groundnut production. Although the soil system is rich in P, 95–99 % of the soil total P is present in an insoluble form and thrives due to binding to the inorganic minerals or organic matter causing about 43 percent of the soils to be deficient in available phosphorus for plant growth” [1,2]. On the other hand, phosphate rock as a raw material for phosphate fertilizer is a limited resource, which also emphasizes the urgent need to improve the availability of soil phosphorus for plant growth. “Concern over security of supply and fluctuating costs of phosphorus fertilizers has resulted in increased interest in microorganisms that aid plant uptake of phosphorus (P) from soil” [3]. Use of only chemical fertilizers can cause soil degradation, nitrogen leaching, water pollution and reduction in soil organic matter content as well as beneficial microbial population and growth. Sole use of chemical fertilizers can increase the cost of cultivation, hence integration of organic, chemical, and biological sources of plant nutrients are essential in management and maintaining of soil health in sustainable agriculture.

## 2. MATERIALS AND METHODS

A field experiment entitled “Effect of integrated use of phosphorus fertilizers and biofertilizers

on growth and yield of groundnut (*Arachis hypogaea* L.)” was conducted during *rabi*, 2022 at Wetland farm, S.V. Agricultural College, ANGRAU, Tirupati, Andhra Pradesh which is geographically situated at 13° 57' 585" N latitude and 79° 68' 695" E longitude that is 183.7 meters above mean sea level and is located in Andhra Pradesh's Southern Agro Climatic Zone.

The analytical results revealed that the soil was slightly alkaline in reaction, non-saline, low in organic carbon and nitrogen, and medium in available phosphorus and potassium. There were eight treatments and three replications in the randomized block design experiment. The treatments combine phosphorus fertilizers with biofertilizers like PSB and Arbuscular Mycorrhiza are: Control (T<sub>1</sub>), 100% RDP (T<sub>2</sub>), 100% RDP (T<sub>3</sub>), 75% RDP + liquid PSB (T<sub>4</sub>), 100% RDP + liquid PSB (T<sub>5</sub>), 75% RDP + AM (T<sub>6</sub>), 50% RDP + liquid PSB + AM (T<sub>7</sub>), 75% RDP + liquid PSB + AM (T<sub>8</sub>).

## 3. RESULTS AND DISCUSSION

### 3.1 Growth Parameters

The information shown in Table 1 indicates that the growth parameters, such as dry matter production, plant height, and number of nodules plant<sup>-1</sup>, were significantly affected by the combined application of fertilizers and biofertilizers, including control. It was found that the dry matter production with the highest numerical value (6073 kg ha<sup>-1</sup>), plant height (44.70 cm), number of nodules plant<sup>-1</sup> (71.67) were observed with the T<sub>8</sub> treatment which constitutes 75% RDP + liquid PSB + AM at harvest. The treatments that yielded the highest growth parameters were those that

applied 75% RDP + liquid PSB + AM (T<sub>8</sub>) might be due to solubilization of unavailable phosphorus to available phosphorus by PSB and AM. It results in the plant to develop fully in terms of its roots and shoots, which may have increased the amount of nutrients it absorbs, increased metabolic activity in plants appears to have encouraged meristematic activity by supplying enzymes that led to apical development [2]. More dry matter is produced as a result of improved cytokinin and indole acetic acid activity caused by VAM. Similar results were reported by Donga and Mathukia [4].

### 3.2 Yield Attributes

With the combined application of phosphate fertilisers and biofertilizers, along with control, there was a substantial difference observed in the yield parameters data, namely the number of filled pods plant<sup>-1</sup> and the number of illfilled pods plant<sup>-1</sup> (Table 2). Whereas, there was no significant effect on 100 pod weight (g), 100 kernel weight (g) and shelling percentage. Further, it was revealed that among all the treatments including the control, treatment with 75% RDP + liquid PSB + AM (T<sub>8</sub>) had significantly shown maximum number of filled pods plant<sup>-1</sup> (12.50) followed by T<sub>3</sub> (100% RDP + liquid PSB) (11.38). The treatments T<sub>5</sub>, T<sub>4</sub>, T<sub>2</sub>, T<sub>6</sub> and T<sub>7</sub> were on par with each other while control (8.03) being the lowest. Notably the lowest number of illfilled pods plant<sup>-1</sup> of 3.00 was recorded with the application of 75 % RDP + Liquid PSB + VAM (T<sub>8</sub>) followed by 100 %

RDP + Liquid PSB (T<sub>3</sub>) (3.67). The increased availability of metabolites might have favored a better translocation of assimilates to the sink and has led to an improvement in the yield attributes and resulted in a greater number of pods. Proper partitioning can lead to better pod development and, in the context, it can help to reduce the number of ill-filled pods. These results were concomitant with the findings of Vyshnavi *et al.* [5] and Sunitha *et al.* [6].

### 3.3 Yield

#### 3.3.1 Pod yield

Pod yield data was presented in Table 3 and illustrated in Fig 1. Substantially, the maximum pod yield of 3704.33 kg ha<sup>-1</sup> was attained by using 75% RDP + liquid PSB + AM (T<sub>8</sub>) followed by T<sub>3</sub> (100% RDP + liquid PSB). The treatments T<sub>4</sub>, T<sub>2</sub>, T<sub>5</sub>, T<sub>6</sub> and T<sub>7</sub> treatments were on par with each other. The lowest pod yield of 2518.47 kg ha<sup>-1</sup> was recorded with the control (T<sub>1</sub>). The increase in pod yield following the inoculation of Phosphorus solubilizing bacteria may be attributable to an increase in P availability brought on by the solubilization of insoluble inorganic phosphate, the breakdown of phosphate-rich organic compounds, and the generation of chemicals that stimulate plant growth. The application of PSB or VAM biofertilizer together with a P source like SSP improved the pod yield, which could be due to increased availability of P and suitably matched the requirement of P by crop. Similar results were reported by [1] Mohanty *et al.* [7].

**Table 1. Effect of phosphorus, PSB and VAM on growth parameters of groundnut**

Treatment	Dry matter Production (kg ha <sup>-1</sup> )	Plant Height (cm)	Number of nodules plant <sup>-1</sup>
T <sub>1</sub> : Control	5772	34.10	64.67
T <sub>2</sub> : 100 % recommended dose of phosphorous fertilizers (RDP)	5923	40.80	68.00
T <sub>3</sub> : 100 % RDP + liquid PSB	6003	43.30	69.67
T <sub>4</sub> : 75 % RDP + liquid PSB	5967	42.03	69.00
T <sub>5</sub> : 100 % RDP + Arbuscular Mycorrhiza	5934	41.06	68.67
T <sub>6</sub> : 75% RDP + Arbuscular Mycorrhiza	5887	39.70	66.67
T <sub>7</sub> : 50 % RDP + liquid PSB + Arbuscular Mycorrhiza	5821	38.80	65.67
T <sub>8</sub> : 75 % RDP + liquid PSB + Arbuscular Mycorrhiza	6037	44.70	71.67
S.Em+	11.33	0.439	0.512
CD@5%	34.35	1.33	1.55

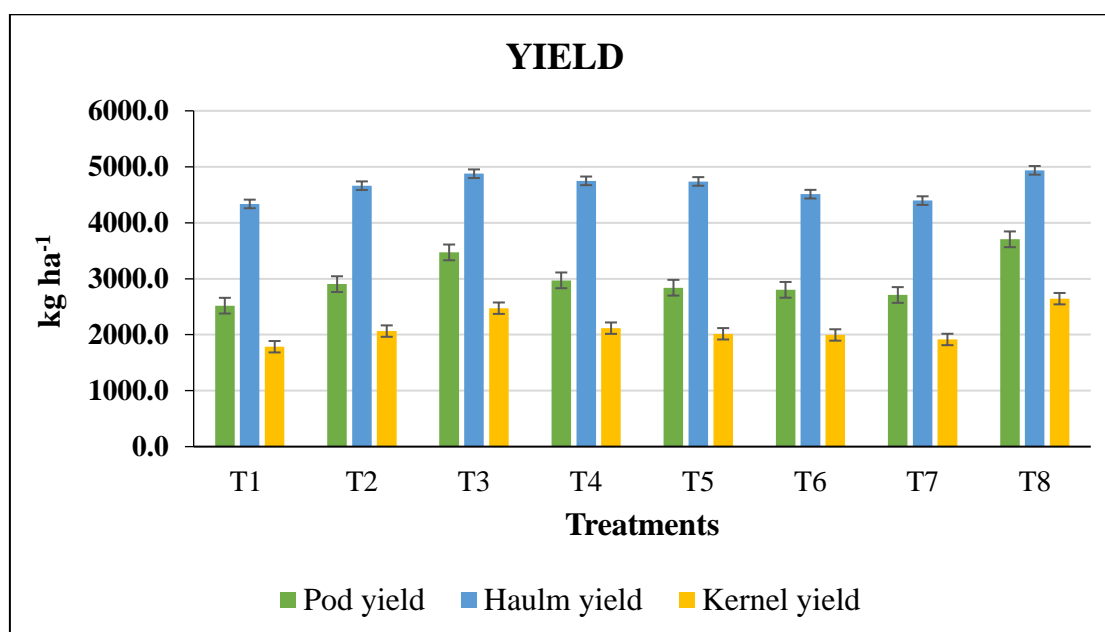
**Table 2. Effect of phosphorus, PSB and VAM on yield attributes of groundnut**

Treatments	Filled pods	Ill-filled pods	100 pod weight(g)	100 kernel weight (g)	Shelling %
T <sub>1</sub>	8.03	6.00	94.90	39.33	70.87
T <sub>2</sub>	10.00	4.33	97.00	40.33	71.10
T <sub>3</sub>	11.38	3.67	97.33	39.67	71.27
T <sub>4</sub>	10.57	4.30	96.97	40.67	71.23
T <sub>5</sub>	10.70	3.97	97.33	40.33	71.00
T <sub>6</sub>	9.12	4.67	96.00	39.67	71.20
T <sub>7</sub>	9.07	5.17	96.33	40.00	71.14
T <sub>8</sub>	12.50	3.00	97.50	40.67	71.37
S. Em ±	0.331	0.211	11.199	0.381	0.1
CD @5 %	1.00	0.64	NS	NS	NS

**Table 3. Effect of phosphorus, PSB and VAM on pod, haulm and kernel yield of groundnut**

Treatments	Pod yield (kg ha <sup>-1</sup> )	Haulm yield (kg ha <sup>-1</sup> )	Kernel yield (kg ha <sup>-1</sup> )
T <sub>1</sub> : Control	2518.47	4342.70	1784.90
T <sub>2</sub> : 100 % recommended dose of phosphorous fertilizers (RDP)	2903.30	4662.33	2064.40
T <sub>3</sub> : 100 % RDP + liquid PSB	3470.43	4876.17	2473.43
T <sub>4</sub> : 75 % RDP + liquid PSB	2971.17	4748.93	2116.57
T <sub>5</sub> : 100 % RDP + Arbuscular Mycorrhiza	2839.45	4738.27	2015.80
T <sub>6</sub> : 75% RDP + Arbuscular Mycorrhiza	2801.63	4510.87	1994.92
T <sub>7</sub> : 50 % RDP + liquid PSB + Arbuscular Mycorrhiza	2709.50	4396.00	1914.34
T <sub>8</sub> : 75 % RDP + liquid PSB + Arbuscular Mycorrhiza	3704.33	4936.60	2643.75
S. Em ±	52.59	18.671	37.066
CD @5 %	159.5	56.63	112.43

Recommended dose of fertilizer: 20- 50- 0 kg N- P<sub>2</sub>O<sub>5</sub>- K<sub>2</sub>O ha<sup>-1</sup>



**Fig. 1. Effect of phosphorus, PSB and AM on pod, haulm and kernel yield (kg ha<sup>-1</sup>) of groundnut crop**

### 3.3.2 Haulm yield

Data pertaining to haulm yield was given in Table 3 and depicted in Fig. 1. The highest haulm yield of 4936.60 kg ha<sup>-1</sup> was obtained with the application of 75% RDP + liquid PSB +AM followed by 100 % RDP + liquid PSB (T<sub>3</sub>) (4876.17 kg ha<sup>-1</sup>) and 75 % RDP + Liquid PSB (T<sub>4</sub>) (4748.93 kg ha<sup>-1</sup>) which in turn was on par with 100 % RDP + Liquid PSB (T<sub>5</sub>) with the production of 4738.27 kg ha<sup>-1</sup>. The next best treatment was 100 % RDP (T<sub>2</sub>) (4662.33 kg ha<sup>-1</sup>) followed by 75 % RDP + AM (T<sub>6</sub>) (4510.87 kg ha<sup>-1</sup>) and 50 % RDP + Liquid PSB + AM (T<sub>7</sub>) (4395.97 kg ha<sup>-1</sup>). The lowest haulm yield of 4336.33 kg ha<sup>-1</sup> was recorded in control (T<sub>1</sub>). The increase in haulm yield due to application of 75 % RDP + Liquid PSB + AM might be due to the addition of inorganic phosphorus as well as phosphorus solubilizers and mobilizers may have enhanced plant nutrient absorption and led to the production of higher-quality photosynthates and a greater haulm yield. Similar results were reported by Rajbalasharma et al. [8].

### 3.3.3 Kernel yield

Data pertaining to kernel was given in Table. 3 and depicted in Fig. 1. The highest of 2643.75 kg ha<sup>-1</sup> was obtained with the application of 75% RDP + liquid PSB +AM The next best treatment was 100 % RDP + liquid PSB (T<sub>3</sub>) (4876.17 kg ha<sup>-1</sup>) followed by 75 % RDP + Liquid PSB (T<sub>4</sub>) (2116.57 kg ha<sup>-1</sup>). The treatments T<sub>4</sub>, T<sub>2</sub>, T<sub>5</sub>, T<sub>6</sub> and T<sub>7</sub> were on par with other. The lowest kernel yield of 1784.90 kg ha<sup>-1</sup> was recorded in control (T<sub>1</sub>). The application of phosphorus along with PSB and AM led to a significant increase in kernel yield, as they are important for energization processes, profuse nodulation, and are constituents of ribonucleic acid, deoxyribonucleic acid, and ATP, which regulate essential metabolic processes in plants and aid in root formation. Nitrogen fixation also benefits photosynthetic organs. [9, 10].

## 4. CONCLUSION

Finally, it can be said that the growth and yield characteristics of the groundnut crop were improved by the application of 75% RDP + liquid PSB + AM (T<sub>8</sub>) compared to 100% RDP and control. It suggests that a 25% reduction in RDP could still produce a satisfactory yield when PSB and VAM are used in its place.

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## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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