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Effect of phosphorus management with bio-agents on yield and yield attributes of groundnut (*Arachis hypogea* L.)

B Rakesh, A Prasanthi, MVS Naidu and S Tirumala Reddy

Abstract
A field experiment entitled "Effect of phosphorus management with bio-agents on growth and yield of groundnut (*Arachis hypogea* L.)" was carried out during *rabi*, 2020 at Wetland Farm, S.V. Agricultural College, Tirupati campus (under the judicatory of Acharya N.G. Ranga Agricultural University). The experiment was laid out in a randomized block design with nine treatments. Phosphorus management practices were significantly influenced the growth and yield of groundnut crop. The highest pod yield and number of filled pods plant^{-1} was recorded with the application of 100% RDP + Liquid PSB + VAM (T7) whereas highest haulm yield was recorded with the application of 125% RDP + Liquid PSB + VAM (T9). 100 pod weight, 100 kernel weight, shelling percentage were non significantly influenced by the application of inorganic phosphorus, liquid PSB and VAM.

Keywords: Groundnut, liquid PSB, VAM

1. Introduction
Groundnut (*Arachis hypogaea* L.) is one of the important oilseed crops for small land holding farmers of rainfed areas. Globally, Asia and Africa share around 95% of cultivated area and 87% of production due to their most suitable agro-climatic condition for groundnut cultivation (FAO, 2016) [3]. In India, it is second most important oilseed with acreage of 5.86 million hectares with a production of 8.27 million tonnes and an average productivity of 1411 kg ha^{-1} (Anonymous, 2016) [1]. Groundnut occupies about 45% of the total area under oilseeds and 55% of the total oilseeds production. Groundnut seeds contain good quality edible oil (48%), easily digestible carbohydrates and proteins.

In Andhra Pradesh, groundnut is mainly grown in Rayalaseema districts namely Chittoor, Ananthapur, Kadapa and Kurnool. Well drained friable, red soils, loose sandy loams are preferred. In Andhra Pradesh total area under oil seeds is 9.15 Lakh ha, which constitutes 12.29% of the total cropped area in the state.

Phosphorus is one among the major essential macronutrients next to nitrogen, and is applied to soil in the form of inorganic phosphate fertilizer. However, a large portion of applied soluble inorganic chemical P to the soil is rapidly immobilized and unavailable to plants. Currently, the main purpose of the study is phosphorus management to minimize phosphorous loss from soils and optimize crop production. Phosphorous solubilizing bacteria (PSB) are beneficial bacteria having the capacity to solubilize inorganic P from insoluble compounds. Hence, PSB have been introduced to the farming community as phosphate bio-fertilizer. Arbuscular mycorrhizal association can be characterized as inducible mutualistic symbiosis involving bi-directional transfer of resources. Phosphorus availability and fertilizer phosphorus use efficiency can be increased with mycorrhiza and phosphorus solubilizing bacteria which mobilize and solubilise the soil phosphates and hence, make them available to the plants.

2. Material and Methods
The experiment entitled "Effect of phosphorus management with bio-agents on yield and yield attributes of groundnut (*Arachis hypogea* L.)" was conducted during rabi, 2020 at S.V. Agricultural College, Tirupati, Acharya N.G. Ranga Agricultural University, which is geographically situated at 13° 56' 564" N latitude and 79° 67' 684" E longitude, with an altitude of 182.9 m above the mean sea level, which falls under Southern Agro Climatic Zone of Andhra Pradesh. According to Trolls classification, it comes under the Semi-Arid Tropics (SAT). The experimental soil was sandy loam in texture.

The analytical data indicated that the soil was alkaline in reaction, normal in soluble salt concentration, low in organic carbon, nitrogen and medium in phosphorus and potassium. The experiment was laid out in randomized block design with nine treatments and replicated thrice. The treatment consists of combination of phosphorus fertilizer with biofertilizers like liquid PSB and VAM are:

100% Recommended dose of phosphorus (RDP) (T1), 125% Recommended dose of phosphorus (RDP) (T2), 75% Recommended dose of phosphorus (RDP) (T3), 75% RDP + Liquid PSB (T4), 75% RDP + Liquid PSB + VAM (T5), 100% RDP + Liquid PSB (T6), 100% RDP + Liquid PSB + VAM (T7), 125% RDP + Liquid PSB (T8), 125% RDP + Liquid PSB + VAM (T9). Dharani variety of groundnut is used for sowing with a spacing of 22.5 x 10 cm. The observations on pod yield, halum yield, Number of filled pods plant^{-1}, Number of illfilled pods plant^{-1}, 100 pod weight, 100 kernel weight, shelling percentage at harvest were recorded.

3. Results and Discussion

3.1 Yield attributes

3.1.1 Number of filled pods plant^{-1}

Significantly the highest number of filled pods plant^{-1} of 14.3 was recorded with application of 100% RDP + Liquid PSB + VAM (T7) which was comparable with application of 100% RDP + Liquid PSB (T6), 125% RDP + Liquid PSB + VAM (T9), 125% RDP + Liquid PSB (T8) and also 75% RDP + PSB + VAM (T5) recorded the filled pods of 14.0, 13.3, 13.2 and 12.7, respectively. These above treatments are in turn significant over the application of 75% RDP + PSB (T4), 125% RDP (T2) and 100% RDP (T1) which resulted in filled pods plant^{-1} of 11.2, 11.1 and 11.0, respectively and these treatments are comparable with each other. The lowest filled pods plant^{-1} of 10.3 was recorded with the application of 75% RDP (T3).

The highest number of filled pods was recorded with the application of 100% RDP + Liquid PSB + VAM which might be due to better interception, absorption and utilization of radiation energy leading to higher photosynthetic rate and finally more accumulation. The overall improvement reflected into better source- sink relationship, which in turn enhanced the yield attributes. This was in concormitant with the findings of Kulakarni *et al*. (2018).

3.1.2 Number of illfilled pods

Number of illfilled pods plant^{-1} was significantly influenced by phosphatic fertilizer and biofertilizers (Liquid PSB, VAM). Significantly the lowest number of illfilled pods plant-1 of 3.3 was recorded with the application of 100% RDP + Liquid PSB + VAM (T7) which was found to be superior over rest of the treatments. The next best treatment was the application of 100% RDP + Liquid PSB (T6) which was on par with 125% RDP + Liquid PSB + VAM (T9), 125% RDP + Liquid PSB (T8) and also 75% RDP + PSB + VAM (T5) recorded illfilled pods plant^{-1} of 3.8, 4.0, 4.4, and 4.5, respectively and found to be superior over remaining treatments. This was followed by the application of 75% RDP + PSB (T4), 125% RDP (T2) and 100% RDP (T1) which resulted in illfilled pods plant^{-1} of 4.9, 4.9 and 5.0, respectively and comparable with each other. Significantly the highest number of illfilled pods plant^{-1} of 5.7 was recorded with application of 75% RDP (T3).

The lowest number of illfilled pods was recorded with the application of 100% RDP + Liquid PSB + VAM (T7) might be due to beneficial effect of phosphate solubilizing bacteria and VAM increased the availability of phosphorus, enhanced photosynthesis, production of photosynthates and their partitioning between vegetative and reproductive structure might have helped in improving the yield attributes. These results are in accordance with the findings of Solanki *et al*. (2020) [7].

3.1.3 100 Pod weight

100 pod weight of groundnut crop was not significantly influenced by the various treatments. The highest 100 pod weight of 101.9 g was produced with the application of 125% RDP + Liquid PSB + VAM (T9) and 125% RDP + Liquid PSB (T8). The lowest 100 pod weight of 98.6 g was recorded with the application of 75% RDP (T3).

3.1.4 100 Kernel weight

Significant difference could not be noticed with application of phosphatic fertilizer and biofertilizers (Liquid PSB, VAM) in terms of test weight. The highest test weight of 42.9 g was recorded with the application of 125% RDP + Liquid PSB + VAM (T9) and the lowest test weight of 40.1 g was recorded with application of 75% RDP (T3)

3.1.5 Shelling percentage (%)

Application of phosphatic fertilizer and biofertilizers (Liquid PSB, VAM) could not exhibit any significant difference among the treatments. The highest shelling percentage of 72.9% was produced with the application of 125% RDP + Liquid PSB + VAM (T9) and the lowest shelling percentage of 70.2% was recorded with the application of 75% RDP (T3).

3.2 Yield

3.2.1 Pod yield

Pod and halum yield in groundnut significantly influenced by the application of PSB and VAM. The data was presented in Table 2.

Significantly the highest pod yield of was recorded with application of 100% RDP + Liquid PSB + VAM (T7) (3809 kg ha^{-1}) which was comparable with application of 125% RDP + Liquid PSB + VAM (T9) (3797 kg ha^{-1}), 125% RDP + Liquid PSB (T8) (3709 kg ha^{-1}) and also 100% RDP + Liquid PSB (T6) (3691 kg ha^{-1}). The next best treatment was recorded with the application of 75% RDP + PSB + VAM (T5) 3484 kg ha^{-1} which was comparable with each other 125% RDP (T2) (3395 kg ha^{-1}), 75% RDP + PSB (T4) (3386 kg ha^{-1}) and 100% RDP (T1) (3331 kg ha^{-1}). The lowest pod yield of 3158 kg ha^{-1} was recorded with the application of 75% RDP (T3).

The highest pod yield recorded with application of 100% RDP + Liquid PSB + VAM (T7) might be attributed to better supply of nutrients along with conducive physical environment leading to better root activity and higher nutrient absorption, which resulted in more plant growth and superior yield attributes responsible for higher yield. The application of biofertilizers (PSB and VAM) increased the efficiency of chemical fertilizers due to control release of nutrients in the soil through microbial activity which might have facilitated better crop growth. These results are in agreement with findings of Mahanta (2008) [5] and Nareshkumar *et al*. (2018) [6].

3.1.5 Haulm yield

Significantly the highest haulm yield (5294 kg ha^{-1}) was recorded with application of 125% RDP + Liquid PSB +

VAM (T9) which was on par with application of 125% RDP + Liquid PSB (T8) and also 100% RDP + Liquid PSB + VAM (T7) resulted the haulm yields of 5266 kg ha^{-1} and 5243 kg ha^{-1}, respectively. These above treatments are in turn significantly superior over the application of 100% RDP + Liquid PSB (T6) and 75% RDP + PSB + VAM (T5) which resulted in haulm yield of 4961 kg ha^{-1} and 4940 kg ha^{-1}, respectively and these treatments are comparable with each other and significantly superior over rest of the treatments. This was followed by the application of 75% RDP + PSB (T4) which in turn was comparable with 125% RDP (T2) and 100% RDP (T1) recording the haulm yields of 4662 kg ha^{-1}, 4639 kg ha^{-1} and 4637 kg ha^{-1}, respectively. However, these treatments were significantly superior over 75% RDP (T3) which recorded significantly the lowest haulm yield of 4344 kg ha^{-1}.

The increase in haulm yield due to application of 125% RDP + Liquid PSB + VAM might be due to addition of inorganic phosphorus and phosphorus solubilizers and mobilizers which might increase the uptake of plant nutrients to manufacture more quality of photosynthates resulting higher haulm yield. Furthermore, VAM not only supplies essential nutrients but also water to plants resulting in better growth that led to increased haulm yield. Similar results were reported by Choudary *et al*. (2011).

Table 1: Effect of phosphorous management with bio-agents on yield attributes of groundnut

Treatments	No. of filled pods plant^{-1}	Number of illfilled^{-1}	100 Pod weight (g)	100 Kernel weight (g)	Shelling percentage (%)
T1	11.0	5.0	99.1	41.0	70.9
T2	11.1	4.9	100.1	41.3	71.2
T3	10.3	5.7	98.6	40.1	70.2
T4	11.2	4.9	99.1	41.0	71.0
T5	12.7	4.5	99.9	41.1	71.2
T6	14.0	3.8	100.7	41.8	71.7
T7	14.3	3.3	101.2	42.1	72.0
T8	13.2	4.4	101.9	42.3	72.5
T9	13.3	4.0	101.9	42.9	72.9
S.Em ±	0.5	0.1	1.6	0.7	1.2
CD 5%	1.4	0.4	NS	NS	NS

Table 2: Effect of phosphorous management with bio-agents on pod and haulm yield of groundnut

Treatments	Pod yield (kg ha^{-1})	Haulm yield (kg ha^{-1})
T1 : 100% Recommended dose of phosphorus (RDP)	3331	4637
T2 : 125% Recommended dose of phosphorus (RDP)	3395	4639
T3 : 75% Recommended dose of phosphorus (RDP)	3158	4344
T4 : 75% RDP + Liquid PSB	3386	4662
T5 : 75% RDP + Liquid PSB + VAM	3484	4940
T6 : 100% RDP + Liquid PSB	3691	4961
T7 : 100% RDP + Liquid PSB + VAM	3809	5243
T8 : 125% RDP + Liquid PSB	3709	5266
T9 : 125% RDP + Liquid PSB + VAM	3797	5294
S.Em ±	107	121
CD 5%	324	375

4. Conclusion

Finally it can be concluded that application of 100% RDP + Liquid PSB + VAM can be advocated as a best phosphorus management practice using biofertilizers for enhancing the productivity and profitability under Southern Agro Climatic Zone of Andhra Pradesh.

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