The Pharma Innovation Journal 2021; 10(8): 393-397

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2021; 10(8): 393-397

www.thepharmajournal.com
Received: 08-05-2021
Accepted: 19-06-2021

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# Impact of phosphorus management along with FYM and bio-inoculants on yield and yield attributes of groundnut

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**Abstract**
Yield and yield attributes of groundnut were evaluated with the application of different levels of phosphorus fertilizer along with FYM, and bio-inoculants during *Rabi* 2020. The experiment was laid out in Randomized Block Design and replicated thrice, conducted at Agricultural College Farm, Bapatla. The treatments comprised of $T_1$ - 100% RDP, $T_2$ - FYM + PSB + VAM (without P), $T_3$ - 100% RDP + FYM + PSB, $T_4$ - 100% RDP + FYM + VAM, $T_5$ - 100% RDP + FYM + PSB + VAM, $T_6$ - 75% RDP + FYM + PSB, $T_7$ - 75% RDP + FYM + VAM, $T_8$ - 75% RDP + FYM + PSB + VAM. The results indicated that the combined application of inorganic fertilizer + FYM + biofertilizer proved significantly superior over - application of FYM and biofertilizers alone without adding inorganic phosphorus fertilizer in obtaining better growth and higher yield of groundnut and the yield was increase with the application of 75% RDP + FYM + PSB + VAM over 100% RDP alone which indicates that the reduction in RDP of 25% could be able to get the good yield by substituting this with FYM, PSB and VAM. The highest shelling percentage and test weight (100 kernel weight) was recorded with the application of $T_5$ over a$T_1$.

**Keywords:** Groundnut, bio-inoculants, FYM, yield, shelling percentage and test weight

## Introduction
Groundnut (King of vegetable oil seeds) is not only an important oilseed crop but also a four-fold crop i.e., food, fodder, feed, and bio-fertilizer. It is a rich source of oil (47-53%), protein (26%), and starch (11.5%). In the national edible oil economy, it occupies a pre-eminent position. The area and production of groundnut in India are 4.91 million hectares and 9.18 million tonnes. In Andhra Pradesh area under Groundnut crop is about 0.74 million hectares & production is 1.04 million tonnes (Anon, 2018) [1].

Phosphorus (P) is one of the most important second primary nutrient. It plays a key role in virtually all biochemical processes that involve energy transfer. Soils vary widely in their capacity to supply phosphorus to crops because only small fractions of the total P in soils are available to crops. It plays a major role in nodulation, biological nitrogen fixation and increases the availability of the residual nutrients (Yakubu *et al*., 2010) [20] and significantly contributes to healthy and efficient root growth (Mitran *et al*., 2018) [12].

Biofertilizers are most likely called bio-inoculants as they are the preparations containing living or latent cells of micro-organisms that help the crop plants through uptake of nutrients by their interactions within the rhizosphere once applied through the seed or soil. It hastens bound microorganisms, processes in the soil that enhance the extent of nutrients in an identical form simply assimilated by plants. (Bahadur *et al*., 2006) [2].

Phosphorus use efficiency in agricultural systems is very low, with only 10-20% of fertilizer P used by crops (Johnston and Syers, 2009) [7]. Typically, fertilizer P is converted to less soluble forms due to reactions with aluminium (Al) and/or iron (Fe) in acid soils and with calcium in neutral to alkaline soils (Soffe 2003; Mitran *et al.*, 2016) [15, 11]. Mutual use of organic and chemical and biofertilizers enhances crop production and sustains soil fertility (Gupta *et al*., 2003) [6]. Keeping all these points in view an experiment was conducted to evaluate impact of phosphorus management along with FYM and bio-inoculants on yield and yield attributes of groundnut.

## Material and Methods
A field experiment was conducted at Agricultural College Farm, Agricultural College, Bapatla during *Rabi*, 2020. Kadiri-9 (K-9) was seeded on sandy clay loam soil with a spacing of 30

cm×10 cm in a Randomised Block Design with three replications. The experimental soil was sandy clay loam in texture, neutral in nature, low in organic carbon, low in available nitrogen, medium in available phosphorus and high in available potassium and sufficient in all micronutrients (Zn, Fe, Mn, Cu). The experiment consisted of eight treatments *viz.*, $T_1$ - 100% RDP, $T_2$ - FYM + PSB + VAM (Control, without P), $T_3$ - 100% RDP + FYM + PSB, $T_4$ - 100% RDP + FYM + VAM, $T_5$ - 100% RDP + FYM + PSB + VAM, $T_6$ - 75% RDP + FYM + PSB, $T_7$ - 75% RDP + FYM + VAM, $T_8$ - 75% RDP + FYM + PSB + VAM. Well decomposed farmyard manure @ 10 t ha$^{-1}$ was applied before sowing. A recommended dose of nitrogen @ 35 kg ha$^{-1}$ was applied in the form of urea in two equal splits *i.e.*, half as basal and half at 30 days after sowing. The recommended dose of $P_2O_5$ @ 40 kg ha$^{-1}$ was applied as per the treatments as basal just before sowing through single super phosphate. A recommended dose of 50 kg $K_2O$ ha$^{-1}$ was applied as muriate of potash as basal application. Biofertilizers *viz.*, PSB @ 1L ha$^{-1}$ and VAM @ 12.5 kg ha$^{-1}$ were mixed with farm yard manure and applied as per the treatments. Recommended cultural practices and plant protection measures were taken throughout the cropping season.

Drymatter accumulation (kg ha$^{-1}$) was obtained by taking five plants from the second row, they were dried first in shade and then in a hot air oven at 65$^0$C till a constant weight was obtained. Then dry weights were recorded and drymatter was expressed in kg ha$^{-1}$. Haulm yield (kg ha$^{-1}$) was obtained by plants from the net plot area after harvesting were sun-dried till constant weight was obtained and their weight was recorded as per plot basis. Pod and kernel yield (kg ha$^{-1}$) was obtained by pods and kernels from the net plot area were cleaned and pod weight was recorded based on dry pod and kernel yield kg per plot. Later the pod and kernel yield per net plot was computed on a hectare basis and expressed in kg ha$^{-1}$. Shelling percentage was obtained by a random sample of 0.2 kg of pods was taken from net plot produce, shelled and the kernel weight was recorded to work out the shelling percentage and expressed in terms of percentage (%) (Singh and Oswalt. 1995) [13].

$$\text{Shelling percentage} = \frac{\text{Kernel weight}}{\text{Pod weight}} \times 100$$

Test weight (100 kernel no) was obtained by A hundred kernels were taken randomly from the net plot of each treatment and their weight was recorded in grams.

All the data recorded in the study were subjected to statistical analysis using Panse and Sukhatme (1978) adopted in this study. Statistical significance was tested by applying F-test at 0.05 level of probability and critical differences were calculated for those parameters, which were found significant ($p<0.05$) to compare the effects of different treatments.

## Results and Discussion

### Drymatter Accumulation

Significant increase in drymatter accumulation at peg penetration (3584 kg ha$^{-1}$) and harvest stage (4633 kg ha$^{-1}$) was recorded with the application of 100% RDP + FYM + PSB + VAM over the other treatments except $T_4$ (3431 and 4553 kg ha$^{-1}$) and $T_3$ (3422 and 4465 kg ha$^{-1}$) which was on par with $T_5$. Drymatter accumulation in $T_8$ treatment (75% RDP + FYM + PSB + VAM) (2782 and 3757 kg ha$^{-1}$) was on par with $T_7$ (2757 and 3737 kg ha$^{-1}$), $T_6$ (2679 and 3705 kg ha$^{-1}$) and $T_1$ (2659 and 3692 kg ha$^{-1}$) and significant lowest drymatter accumulation was observed with the application of FYM + PSB + VAM (2460 & 3337 kg ha$^{-1}$) ($T_2$) without application of any inorganic phosphorus fertilizer (Table-1 and figure-1).

Significant increase in drymatter accumulation while application of farm yard manure, biofertilizers and levels of phosphorus rather than without any application of inorganic phosphorus fertilizer was mainly due to higher phosphorus availability which promotes root growth and transformation of energy essential for almost all metabolic processes *viz.*, photosynthesis, respiration, activation of amino acids for synthesis of protein and carbohydrate metabolism which ultimately increase the all the growth attributes (Singh *et al.*, 2010) [14]. Phosphorus also improves production of photosynthates and their translocation from source to sink (Meena *et al.*, 2006, Kumar *et al.*, 2007) [10, 9]. This also might be due to application of FYM and bio-inoculants which increase the availability of the nutrients like N, P which in turn increased physiological processes *viz.*, cell elongation and formation of meristematic activity tissues which ultimately enhanced growth attributes and drymatter production (Karwasra *et al.*, 2007) [8]. In the absence of phosphorus application, vital metabolic processes like phosphorylation and carbohydrate transformation are adversely affected and decrease the growth attributes of the groundnut crop (Stewart and Williams, 1942) [16].

### Pod Yield

The highest (2747 kg ha$^{-1}$) pod yield was recorded with the application of 100% RDP + FYM + PSB + VAM and the lowest (2250 kg ha$^{-1}$) was recorded with the application of FYM + PSB + VAM (Table-1 and figure-2). Combined application of bio-inoculants along with FYM and inorganic phosphorus fertilizer recorded higher pod yield compared to individual application of inorganic phosphorus fertilizer and alone application of FYM and bio-inoculants. There was 22.10% and 9.96% increase in yield over $T_2$ and $T_1$ without any application of inorganic phosphorus fertilizer (FYM + PSB + VAM) and alone application of 100% RDP this might be due to efficient and greater partitioning of metabolites and adequate translocation and accumulation of photosynthesis to developing reproductive structure under adequate fertilization that might have increasingly important growth and yield contributing characters *viz.*, plant spread, number of branches, drymatter accumulation, increase root nodules due to P-solubilizer and nitrifying bacteria also helped in increasing better root development and consequently increasing the absorption of nutrients there by increasing the number of pods which resulted in increased pod yield (Chavan *et al.*, 2014) [3].

### Kernel Yield

The highest kernel yield (2173 kg ha$^{-1}$) recorded with the application of 100% RDP + FYM + PSB + VAM ($T_5$) and it was on par with $T_4$ (2059 kg ha$^{-1}$) and $T_3$ (1946 kg ha$^{-1}$) and it was significantly superior over all other treatments. The kernel yield in $T_8$ treatment (75% RDP + FYM + PSB + VAM) (1828 kg ha$^{-1}$) was on par with $T_7$ (75% RDP + FYM + VAM) (1806 kg ha$^{-1}$), $T_6$ (75% RDP + FYM + PSB) (1769 kg ha$^{-1}$) and $T_1$ (100% RDP) (1725 kg ha$^{-1}$) and significant lowest (1536 kg ha$^{-1}$) kernel yield was recorded with the application of FYM + PSB + VAM ($T_2$) (Table-1 and figure-2).

The significant increase in kernel yield was mainly due to the

application of phosphorus which plays a major role in energisation processes, profuse nodulation and being constituent of ribonucleic acid, deoxyribonucleic acid and ATP, which regulate vital metabolic processes in the plant and also helps in root formation, nitrogen fixation results in a positive effect on photosynthetic organs (Tomar *et al.,* 2006, Erman *et al.,* 2009) [18, 4]. The application of phosphorus solubilizing bacteria enhanced the phosphorus availability to plants by mineralizing organic phosphorus in soil and also the production of plant growth-promoting substances (Gaur and Sunitha, 1999) [5]. The compatibility of P and VAM can be attributed to the fact that the vesicular arbuscular mycorrhiza might be instrumental in mobilizing soluble P and might have increased the surface area of absorption through hyphae, making the nutrients available from inaccessible areas. Besides, the acquisition of organically bound P is improved by acid phosphatase and through hormones released from VAM, which might have exerted beneficial effect on productivity (Tarafdar and Marschener, 1994) [17].

**Shelling Percentage**

The highest shelling percentage (79.23%) recorded with the application of 100% RDP + FYM + PSB + VAM ($T_5$) and it was on par with 100% RDP + FYM + VAM ($T_4$) (75.89%), 100% RDP + FYM + PSB ($T_3$) (72.68%) and lowest (68.24%) was recorded with the application of FYM + PSB + VAM ($T_2$) without any application of inorganic phosphorus fertilizer (Table-1). Efficient and greater partitioning of metabolites and adequate translocation and accumulation of photosynthates, amino acids, vitamins to developing reproductive structures under adequate fertilization could be attributed to an increase in all the yield attributing characters and also reflected in greater shelling percentage (Chavan *et al.*, 2014) [3].

**Test Weight (100 Kernel Weight)**

The highest test weight (42.22g) was recorded with the application of 100% RDP + FYM + PSB + VAM ($T_5$) and it was on par with 100% RDP + FYM + VAM (39.69g), 100% RDP + FYM + PSB (39.49g), 75% RDP + FYM + PSB + VAM (39.35g) and lowest (33.16g) was recorded with the application of FYM + PSB + VAM ($T_2$) without any application of inorganic phosphorus fertilizer (Table-1).

The significant increase in kernel weight was mainly due to improvement in a nutritional environment which might have favourably influenced carbohydrate metabolism which in turn increased the uptake of nutrient and ultimately resulted in increased kernel weight of groundnut (Vala *et al*., 2017) [19].

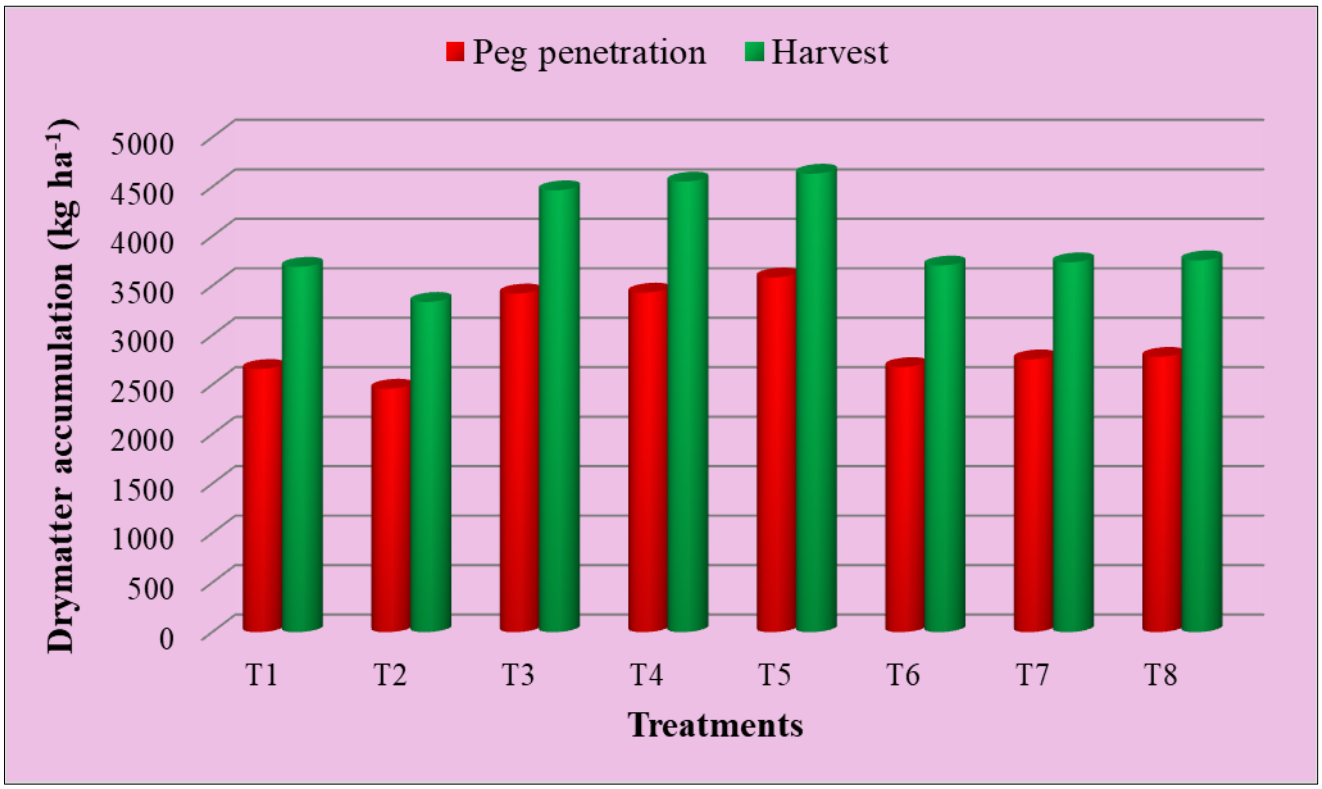


**Fig 1:** Effect of inorganic phosphorus in combination with FYM and bio-inoculants on drymatter accumulation at peg pentation and harvest stages of groundnut

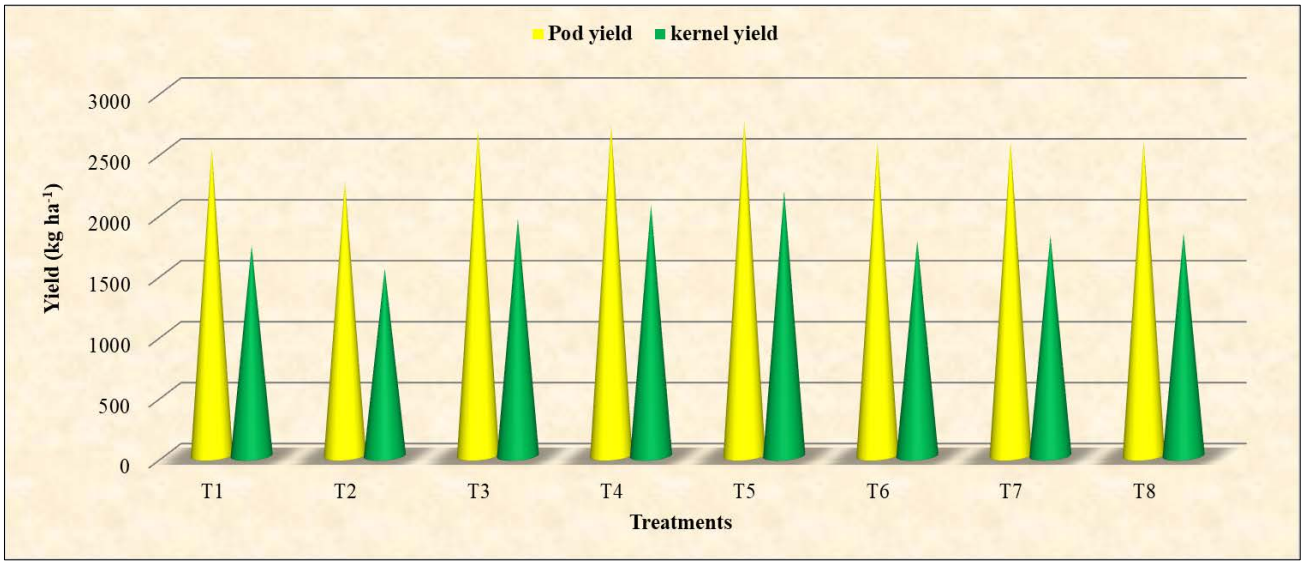


**Fig 2:** Effect of inorganic phosphorus in combination with FYM and bio-inoculants on yield of groundnut

**Table 1:** Effect of inorganic phosphorus in combination with FYM and bio-inoculants on drymatter accumulation and yield attributes of groundnut

| Treatments | Dry matter accumulation (kg ha$^{-1}$) | | | Kernel yield (Kg ha$^{-1}$) | Shelling percentage | 100 kernel weight (g) |
|---|---|---|---|---|---|---|
| | Peg penetration | Harvest | | | | |
| | | Haulm yield | Pod yield | | | |
| $T_1$ - 100% RDP | 2659 | 3692 | 2523 | 1725 | 68.36 | 36.33 |
| $T_2$ - FYM+PSB+VAM (Control, without P) | 2460 | 3337 | 2250 | 1536 | 68.24 | 33.16 |
| $T_3$ -100% RDP+FYM+PSB | 3422 | 4465 | 2676 | 1946 | 72.68 | 39.49 |
| $T_4$ - 100% RDP+FYM+VAM | 3431 | 4553 | 2717 | 2059 | 75.89 | 39.69 |
| $T_5$ - 100% RDP+FYM+PSB+VAM | 3584 | 4633 | 2747 | 2173 | 79.23 | 42.22 |
| $T_6$ - 75% RDP+FYM+PSB | 2679 | 3705 | 2567 | 1769 | 68.89 | 36.93 |
| $T_7$ - 75% RDP+FYM+VAM | 2757 | 3737 | 2580 | 1806 | 70.00 | 37.98 |
| $T_8$ - 75% RDP+FYM+PSB+VAM | 2782 | 3757 | 2585 | 1828 | 70.71 | 39.35 |
| S.Em (±) | 88.12 | 130.88 | 74.84 | 78.89 | 2.22 | 1.19 |
| CD (P = 0.05%) | 267 | 397 | 227 | 239 | 6.74 | 3.62 |
| CV (%) | 5.14 | 5.69 | 5.02 | 7.36 | 5.36 | 5.41 |

## Conclusion

The combined application of inorganic phosphorus fertilizer, FYM and bio inoculants improved the yield and yield attributes of groundnut crop. The yield was increased with the application of 75% RDP + FYM + PSB + VAM over 100% RDP alone which indicates that the reduction in RDP of 25% could be able to get the good yield by substituting this with FYM, PSB and VAM.

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