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Effect of Phosphate Rich Organic Manure (PROM) along with *Pseudomonas* on growth and yield of *rabi* groundnut

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Abstract
Groundnut (*Arachis hypogaea* L.) is an important oilseed crop whose productivity is largely constrained by the limited availability of phosphorus (P) in Indian soils. Phosphate Rich Organic Manure (PROM), when integrated with P-solubilizing microorganism, offers a promising strategy to enhance P availability and crop productivity. The field experiment was conducted during *rabi* 2024-25 at Agricultural College, Aswaraopet, to evaluate the effect of inorganics, PROM and *Pseudomonas fluorescens* on growth and yield of *rabi* groundnut. The experiment consisted of nine treatments laid out in a Randomized Block Design with three replications. Results indicated that combined application of 75% recommended dose of phosphorus (RDP) substituted through PROM + *Pseudomonas fluorescens* soil application @ 7.5 kg ha^{-1} recorded significantly taller plants (30.6 cm), wider leaf area (1156.8 cm² plant^{-1}), maximum dry matter production (6847 kg ha^{-1}) and higher pod yield (2977 kg ha^{-1}), this was was statistically comparable with 100% RDF + *Pseudomonas fluorescens* and 100% RDF. The study demonstrated that integrating PROM with *Pseudomonas fluorescens* bacteria can partially replace chemical fertilizers while improving productivity in groundnut.

Keywords: Groundnut, phosphorus, PROM, *Pseudomonas*

Introduction
Groundnut (*Arachis hypogaea* L.) is one of the most important among edible oilseed crops in the world and belongs to Leguminaceae (Fabaceae) family. In India, 24.4 per cent of *yasangi* season groundnut is cultivated in Telangana state and lion share of area and production are contributed from Southern Telangana zone and little from Central Telangana zone (PJTAU, 2023). Although legumes can fix their own nitrogen, they often need phosphorus, calcium and other nutrients for good seed formation. Phosphorus (P) is the second most important nutrient which favours healthy growth and development of roots and promotes rhizobial activity resulting in increased nodulation and nitrogen fixation (Moharana *et al*., 2015; Jangir *et al*., 2016) [4, 7]. In Indians soils only 16-18% of soil phosphorus is readily available and 80% of soils requires phosphorus application at recommended rates (Motsara, 2002) [8]. Proper phosphorus management enhances root biomass, nodulation and pod yield of groundnut. Phosphate Rich Organic Manure (PROM) is effective alternative to water soluble phosphorus fertilizers, regardless of soil type (Sekhar *et al*., 2012) [10]. PROM is a value added product produced by composting different organic waste with high-grade (32% P_2O_5) rock phosphate in very fine size (80% finer than 54 microns) (Aechra *et al*., 2021) [1]. PROM contains significant amounts of phosphorus (9-10% P_2O_5), carbon-to-nitrogen (C: N) ratio less than 15:1 and a pH of 7.0-7.5 which makes it essential for plant growth, especially early development, root growth and considered as more environment friendly than synthetic fertilizers (Udawat, 2023) [12]. Phosphorus solubilizing strains of the genus *Pseudomonas* (notably *P. fluorescens*) has the ability to improve the availability of nutrients like Ca, Zn, Mo, Cu etc (Jat and Ahlawat, 2008) [5]. Integrating organic P sources like PROM with microbial inoculants such as phosphate solubilizing *Pseudomonas* offers theoretical and practical advantages like higher microbial activity, enhance the solubilization and mobilization of the P contained in PROM, thereby improving available P and crop uptake.

Materials and Methods

The field experiment was carried out at College farm, Agricultural college, Aswaraopet during *rabi,* 2024-2025. Experimental farm lies between $19^0$47' N latitude and $74^0$18' E longitude with 435 m elevation above mean sea level. The soil of the experimental field was sandy loam in texture and nearly neutral in reaction (pH 7.65), low in organic carbon (0.47%), low in available nitrogen (218.53 kg ha^{-1}), low in available phosphorus (10.58 kg ha^{-1}) and medium in potassium status (208.52 kg ha^{-1}). Experiment was laid out in Randomized Block Design (RBD) with three replications and nine treatments. The treatments includes T_1: Absolute control, T_2: 100% RDF, T_3: 50% RDP substituted through PROM, T_4: 75% RDP substituted through PROM, T_5: 100% RDP substituted through PROM, T_6: T_3 + *Pseudomonas florescence* soil application @ 7.5 kg ha^{-1}, T_7: T_4 + *Pseudomonas florescence* soil application @ 7.5 kg ha^{-1}, T_8: T_5 + *Pseudomonas florescence* soil application @ 7.5 kg ha^{-1}, T_9: T_2 + *Pseudomonas florescence* soil application @ 7.5 kg ha^{-1}. Groundnut (variety K6) was sown with spacing of 22.5 cm x 10 cm. Recommended dose of fertilizer was 20:40:50 $N:P_2O_5:K_2O$ kg ha^{-1} was applied through urea, single super phosphate and murate of potash according to treatments. Phosphorus rich compost (PROM) and *Pseudomonas florescence* was applied and thoroughly mixed in soil before sowing as basal application as per treatment. Biometric observations during the crop growth period were recorded periodically on the selected plants. Plant height, leaf area, drymatter production and yield were recorded at harvest stage. Data were subjected to analysis of variance (ANOVA) using online statistical analysis package (OPSTAT) at 5% level of significance (p=0.05).

Results and Discussion

Growth parameters

PROM along with *Pseudomonas* significantly influenced the growth attributes of *rabi* groundnut (Table 1). Among the treatments, significantly taller plants (30.6 cm), wider leaf area (1156.8 cm^2 $plant^{-1}$) and higher drymatter production (6847 kg ha^{-1}) was recorded with application of 75% RDP substituted through PROM + *Pseudomonas fluorescens* soil application @ 7.5 kg ha^{-1} (T_7), it was statistically on par with 100% RDF + *Pseudomonas fluorescens* soil application @7.5 kg ha^{-1} and 100% RDF. These were followed by 75% RDP substituted through PROM (T_4), 50% RDP substituted through PROM + *Pseudomonas fluorescens* soil application @7.5 kg ha^{-1} (T_6), 50% RDP substituted through PROM (T_3) being on par with other. 100% RDP substitution through PROM+ *Pseudomonas fluorescens* soil application @ 7.5 kg ha^{-1} and sole 100% RDP substitution through PROM registered lower growth attributes among nutrient application treatments whereas the shorter plants (17.4 cm), lower leaf area (525.2 cm^2 $plant^{-1}$) and drymatter production (3833 kg ha^{-1}) was observed in the absolute control (T_1). Integrating 75% RDP through PROM + *Pseudomonas fluorescens* @ 7.5 kg ha^{-1} effectively enhanced nutrient availability, particularly phosphorus, improved root growth which might have resulted taller plants, leaf expansion and improved drymatter production. These results were consistent with the findings Singh *et al*. (2014) [11], Ramakrishna *et al*. (2015) [9], Khangarot *et al*. (2022) [6], Yadav *et al*. (2024) and Bachate *et al*. (2024) [3].

Pod yield

The pod yield of *rabi* groundnut were markedly influenced by PROM with *Pseudomonas* application (Table 1). Among the treatments, 75% RDP substituted through PROM + *Pseudomonas fluorescens* soil application @ 7.5 kg ha^{-1} recorded the higher pod yield (2977 kg ha^{-1}). This treatment was statistically comparable with 100% RDF + *Pseudomonas fluorescens* @ 7.5 kg ha^{-1} (2910 kg ha^{-1}) and 100% RDF (2875 kg ha^{-1}). Followed by 75% RDP substituted through PROM (T_4), 50% RDP substituted through PROM + *Pseudomonas fluorescens* soil application @7.5 kg ha^{-1} (T_6), 50% RDP substituted through PROM (T_3) recorded moderate pod yield being on par with other. Application of full phosphorus through PROM (T_7) and 100% RDP through PROM + *Pseudomonas fluorescens* (T_8) recorded lower pod yield (2006, 2260 kg ha^{-1}) of *rabi* groundnut among nutrient management treatments. While untreated control treatment registered significantly lower pod yield (1691 kg ha^{-1}) due to insufficient nutrient supply to crop. Combined application of 75% RDP substituted through PROM + *Pseudomonas fluorescens* contributed to greater assimilate production, which in turn translated into higher reproductive yield. Aechra *et al*. (2017) [1], Wahane *et al*. (2022) [13], Arslan *et al*. (2024) and Bachate *et al*. (2024) [3] reported similar results with PROM and phosphorus solubilizing bacteria integration.

Table 1: Effect of inorganics, PROM with *Pseudomonas* on growth attributes and pod yield of *rabi* groundnut

Treatments	Plant height (cm)	Leaf area (cm^2 $plant^{-1}$)	Drymatter production (kg ha^{-1})	Pod yield (kg ha^{-1})
T_1: Absolute control	17.4	525.2	3833	1691
T_2: 100% RDF	29.6	1074.5	6643	2875
T_3: 50% RDP substituted through PROM	25.8	880.9	5806	2517
T_4: 75% RDP substituted through PROM	26.7	960.4	6009	2598
T_5: 100% RDP substituted through PROM	20.1	645.4	4530	2006
T_6: T_3 + *Pseudomonas fluorescens* soil application @ 7.5 kg ha^{-1}	26.3	919.0	5877	2545
T_7: T_4 + *Pseudomonas fluorescens* soil application @ 7.5 kg ha^{-1}	30.6	1156.8	6847	2977
T_8: T_5 + *Pseudomonas fluorescens* soil application @ 7.5 kg ha^{-1}	23.0	761.0	5177	2260
T_9: T_2 + *Pseudomonas fluorescens* soil application @ 7.5 kg ha^{-1}	30.1	1107.8	6717	2910
S.Em ±	0.89	34.79	188	83.9
CD (p=*0.05*)	2.67	104.31	563	241.6

Conclusion

The results emphasized that application of 75% RDP substituted through PROM + *Pseudomonas fluorescens* @ 7.5 kg ha^{-1} proved to be the most effective treatment, recording maximum plant height, leaf area, dry matter production and pod yield. This treatment was statistically comparable with full recommended fertilizer dose (100% RDF) and 100% RDF + *Pseudomonas fluorescens*, indicating that a substantial portion of chemical phosphorus can be successfully replaced by PROM when combined with an efficient P solubilizing bacterium (*Pseudomonas fluorescens*).

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