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# To study the Solubilized Phosphorus on yield and yield attributes of Rice

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**ABSTRACT: A field experiment was conducted during the *kharif* season of 2022 at Instructional Farm, Alesur, Dau Kalyan Singh College of Agriculture and Research Station, Bhatapara (C.G.) to evaluate the "Efficacy of Solubilized Phosphorus on Plant Growth and Productivity of Rice (*Oryza sativa* L.)". The experiment followed a Randomized Block Design (RBD) with 11 treatments, each replicated three times. Various growth parameters were measured at different stages of the rice crop, and the results were analyzed. The results demonstrated a significant impact of solubilized phosphorus on various growth parameters of rice. At 30, 60, 90 days after transplanting, and at harvest, treatment $T_5$ (75% RDF + Solubilized phosphorus 4 ml/L) consistently exhibited the tallest plant height, the highest number of roots, and the maximum root length. It also resulted in the maximum number of leaves and tillers at 30, 60, 90 days after transplanting, and at harvest. Moreover, treatment $T_5$ (75% RDF + Solubilized phosphorus 4 ml/L) showed the highest grain yield and straw yield at harvest, indicating its positive influence on the yield of rice. The study also examined the dry matter accumulation, crop growth rate, relative growth rate, leaf area index, harvest index, and phosphorus use efficiency. Treatment $T_5$ (75% RDF + Solubilized phosphorus 4 ml/L) consistently showed the maximum values for these parameters at different stages of growth, suggesting its potential in enhancing rice productivity followed by $T_4$ (75% RDF + Solubilized phosphorus 3 ml/L). Assessing the Impact of Solubilized Phosphorus on Rice Growth: Experimenting with 11 treatments, observing growth parameters, revealing significant yield boosts in treatment $T_5$.**

**Keywords:** Solubilized phosphorus, Rice, Yield, productivity, RDF, DKS CARS.

## INTRODUCTION

Developing crop cultivars with increased yield and less dependence on the heavy application of fertilizers is essential for the sustainability of agriculture. Phosphorus (P) is an essential macronutrient for plant growth and development. The phosphorus efficiency of solid phosphorus fertilizer is very low, most of the phosphorus fixed in the soil, which effect the availability of phosphorus to crops. Plants take up P exclusively in the form of inorganic phosphate (Pi). The high chemical fixation rate, slow diffusion and substantial fractions of organically bound P of Pi render it one of the least available nutrients for crop (Vance *et al.*, 2003).

Phosphorus is an essential nutrient and no plant can produce good yield if it suffers from P deficiency (Tandon, 1987). Therefore, P availability form soils to the plants is a key to sustain higher yields. Application of P aided in more vigorous root development, early tillering capacity, early tillers have more panicles and per cent of filled spikelets and good grain quality (Bhattacharyya and Chatterjee 1978).

Now-a-days solubilized phosphorus (liquid phosphorus) made available by private companies in the market. There are need to test their efficacy for commercial utilization of such products. Liquid organic fertilizer (LOF) is a solution derived from the decomposition of organic materials, such as plant matter, animal manure, ash and water (Mangera & Ekowati 2022, Raden *et al.*, 2017 and Avinash *et al.*, 2023).

## MATERIAL AND METHODS

A field experiment was carried out on rice during kharif season, 2022 at Instructional Farm, Alesur, Dau Kalyan Singh College of Agriculture and Research Station, Bhatapara (C.G.). The experiment involving the cultivation of Rice (*Oryza sativa* L.) with the CG Zinc Rice 2 variety took place during the Kharif season of 2022. The study employed a Randomized Block Design to ensure accurate and unbiased results. The date of transplanting the rice was recorded as 27/07/2022. The gross plot size was 7m × 5m, which equals 35 square meters, while the net plot size, where the actual experimentation occurred, was slightly smaller at 6m × 4m, equivalent to 24 square meters. In this experiment, there were 11 different treatments being tested, and each treatment was replicated three times, resulting in a total of 33 plots. To maintain separation between replications, a gap of 1 meter was left between them, and a gap of 0.75 meters separated each individual plot. The Recommended Dose of Fertilizer (RDF) used was 120 kg N, 60 kg $P_2O_5$, and 40 kg $K_2O$ per hectare. The spacing between rows and plants was set at 20 cm × 10 cm (Row × Plant). Overall, the total area used for this experiment covered 1437.5 square meters, providing a comprehensive and controlled environment for studying the CG Zinc Rice 2 variety under various treatments and conditions.

## RESULTS AND DISCUSSION

### *A. Grain yield (t ha$^{-1}$)*

The results presented in Table 1 demonstrate that the significant impact of solubilized phosphorus application on the grain yield of rice. Grain yield is a critical parameter in assessing the productivity and profitability of rice cultivation. The findings indicate that the use of solubilized phosphorus, particularly Solubilized phosphorus, in combination with reduced doses of fertilizer had a substantial effect on the grain yield of rice. Among the significantly maximum grain yield (5.40 t ha$^{-1}$) was observed in treatment $T_5$ (75% RDF + Solubilized phosphorus 4ml/L) which was followed by with treatment $T_4$ (75% RDF + Solubilized phosphorus 3 ml/L) (3.95 t ha$^{-1}$). Significantly minimum grain yield (2.70 t ha$^{-1}$) was seen in treatment $T_1$ Control (No Fertilizer).

The findings from this study suggest that the application of Solubilized phosphorus as a phosphorus solubilizing agent can enhance the nutrient availability and uptake by rice plants, leading to improved grain filling and ultimately higher grain yield. The bioactive phytochemicals and hormones in Solubilized phosphorus promoted cell division and enlargement, photosynthesis, assimilate partitioning to grains, thereby increasing grain weight and yield. The integrated nutrient management approach can be a sustainable means to increase rice yields. It is important to note that other factors such as soil type, weather conditions, and crop management practices can also influence grain yield. These outcomes are consistent with findings of Hussain *et al.* (2020).

### *B. Straw yield (t ha$^{-1}$)*

The results presented in Table 1 present the significant impact of solubilized phosphorus application on the straw yield of rice. Straw yield refers to the above-ground biomass of the rice plant, including stems and leaves, after the grain has been harvested. The findings indicate that the use of solubilized phosphorus, specifically Solubilized phosphorus, in combination with reduced doses of fertilizer had a substantial effect on the straw yield.

Among the data significantly maximum straw yield (7.12 t ha$^{-1}$) was observed in treatment $T_5$ (75% RDF + Solubilized phosphorus 4 ml/L) which was followed by with treatment $T_4$ (75% RDF + Solubilized phosphorus 3 ml/L) (5.65 t ha$^{-1}$).

Significantly minimum straw yield (4.31t ha$^{-1}$) was seen in treatment $T_1$ Control (No Fertilizer). This significant difference in straw yield compared to the treated plots highlights the importance of phosphorus in promoting vegetative growth and biomass accumulation in rice plants.

The result indicates that the application of Solubilized phosphorus as a solubilized phosphorus source in combination with reduced fertilizer doses significantly enhanced the straw yield of rice. The application of Solubilized phosphorus as a solubilized phosphorus source can effectively enhance the nutrient status, resulting in improved growth and biomass production in rice plants. The increased straw yield is beneficial to farmers, as it provides additional organic matter that can be used as a valuable resource for various purposes, including soil amendment and animal feed. These outcomes are consistent with findings of Hussain *et al.* (2020) and Jat (2014).

### *C. Harvest Index (%)*

The harvest index (HI) is an essential parameter that represents the proportion of the total crop biomass allocated to the edible or harvestable part, such as grains, in comparison to the total biomass of the plant. The data presented in Table 2 provide valuable insights into the harvest index of rice under different treatments, including the application of Solubilized phosphorus as a solubilized phosphorus source with RDF.

Among the treatments, treatment T5 (75% RDF + Solubilized phosphorus 4 ml/L) showed the maximum harvest index of 43.1%. This indicates that a significant portion of the total biomass produced by the rice plants in this treatment was allocated to the formation of grains, contributing to a higher yield of harvestable rice. Treatment T8 (50% RDF + Solubilized phosphorus 4 ml/L) also showed a comparable harvest index of 43.3%, which was similar to that of treatment T5. These results suggest that the application of Solubilized phosphorus at 4 ml/L, either with 75% or 50% recommended dose of fertilizer, positively influenced the partitioning of biomass towards grain production, thereby enhancing the harvest index.

On the other hand, treatment $T_1$ (Control with no fertilizer) exhibited the minimum harvest index of 38.2%. This lower harvest index implies that a relatively smaller proportion of the total biomass in this treatment was allocated to grain production, resulting in a reduced yield of harvestable rice.

The higher harvest index observed in the Solubilized phosphorus-treated plots (T5 and T8) indicates a more efficient utilization of assimilates for grain formation. This could be attributed to the beneficial effects of Solubilized phosphorus on various physiological processes, such as enhanced nutrient uptake, improved root development, and increased photosynthetic efficiency, as evidenced by the findings from other growth parameters. By promoting the allocation of biomass towards grains, Solubilized phosphorus has the potential to improve the overall productivity and economic yield of rice crops. These outcomes are consistent with findings of Teli *et al.* (2018).

*D. Phosphorus use efficiency*

Phosphorus use efficiency (PUE) is a critical parameter that reflects the ability of a plant to utilize applied phosphorus fertilizer effectively for growth and yield production. The data presented in Table 3 provide valuable insights into the PUE of rice under different treatments, including the application of Solubilized phosphorus as a solubilized phosphorus source.

Among the treatments, treatment $T_5$ (75% RDF + Solubilized phosphorus 4 ml/L) exhibited the significantly maximum phosphorus use efficiency of 27.80. This indicates that a higher proportion of the applied phosphorus fertilizer was efficiently taken up and utilized by the rice plants in this treatment, resulting in improved growth and development. Treatment $T_4$ (75% RDF + Solubilized phosphorus 3 ml/L) showed a comparable phosphorus use efficiency of 26.45, which was statistically similar to that of treatment $T_5$. These results suggest that the application of Solubilized phosphorus at 4 ml/L and 3 ml/L, both with 75% recommended dose of fertilizer, led to a highly efficient utilization of phosphorus, contributing to enhanced growth and productivity of the rice plants.

Following closely, treatment $T_3$ (75% RDF + Solubilized phosphorus 2 ml/L) showed a phosphorus use efficiency of 26.37. Although it was slightly lower than treatments $T_5$ and $T_4$, it still showed a significantly higher PUE compared to other treatments. This demonstrates that even at a lower concentration of Solubilized phosphorus (2ml/L) with 75% RDF, the rice plants could efficiently use the available phosphorus to support their growth and yield.

In contrast, treatment $T_1$ (Control with no fertilizer) exhibited a phosphorus use efficiency of 0.00. This suggests that without the application of any phosphorus fertilizer, the rice plants were unable to utilize phosphorus efficiently, leading to stunted growth and poor development.

The higher phosphorus use efficiency observed in the Solubilized phosphorus- treated plots ($T_5$, $T_4$ and $T_3$) highlights the positive impact of Solubilized phosphorus as a solubilized phosphorus source. Solubilized phosphorus's ability to solubilize phosphorus in the soil and make it readily available for plant uptake likely contributed to the improved PUE in these treatments. This efficient utilization of phosphorus by the rice plants not only enhances their growth and productivity but also has significant implications for sustainable agriculture and environmental conservation, as it reduces the potential for phosphorus runoff and leaching. The results obtained in the present study are supported by the works of Irfan *et al*. (2020) and Kumar *et al.* (2022).

**Table 1: Grain yield (t ha$^{-1}$), Straw yield (t ha$^{-1}$), Harvest Index (%) and Phosphorus use efficiency as influenced by the Solubilized Phosphorus on yield and yield attributes of Rice.**

| Tr. No. | Treatment details | Grain yield (t ha$^{-1}$) | Straw yield (t ha$^{-1}$) | Harvest Index (%) | Phosphorus use efficiency |
|---|---|---|---|---|---|
| $T_1$ | Control (No Fertilizer) | 2.70 | 4.31 | 38.2 | 0.00 |
| $T_2$ | 100% RDF | 3.61 | 5.16 | 41.2 | 24.68 |
| $T_3$ | 75% RDF + Solubilized phosphorus 2 ml/L | 3.93 | 5.78 | 40.4 | 26.37 |
| $T_4$ | 75% RDF + Solubilized phosphorus 3 ml/L | 3.95 | 5.65 | 41.1 | 26.45 |
| $T_5$ | 75% RDF + Solubilized phosphorus 4 ml/L | 5.40 | 7.12 | 43.1 | 27.80 |
| $T_6$ | 50% RDF + Solubilized phosphorus 2 ml/L | 3.46 | 5.23 | 39.8 | 22.78 |
| $T_7$ | 50% RDF + Solubilized phosphorus 3 ml/L | 3.68 | 5.61 | 39.7 | 24.68 |
| $T_8$ | 50% RDF + Solubilized phosphorus 4 ml/L | 3.91 | 5.11 | 43.3 | 24.76 |
| $T_9$ | Solubilized phosphorus 2 ml/L | 3.37 | 5.52 | 38.0 | 21.45 |
| $T_{10}$ | Solubilized phosphorus 3 ml/L | 3.47 | 5.17 | 40.0 | 21.53 |
| $T_{11}$ | Solubilized phosphorus 4 ml/L | 3.58 | 4.60 | 43.8 | 22.78 |
| **SEm (±)** | | **0.19** | **0.28** | **1.76** | **0.42** |
| **CD (P=0.05)** | | **0.57** | **0.81** | **NS** | **1.23** |

## CONCLUSIONS

Grain yield (t ha$^{-1}$) and Straw yield (t ha$^{-1}$) were found significantly maximum in treatment ($T_5$) 75% RDF + Soluble phosphorus 4 ml/L.

Among the treatments, treatment $T_{11}$ (Solubilized phosphorus 4 ml/) showed the maximum harvest index of followed by $T_8$ (50% RDF + Solubilized phosphorus 4 ml/L).

In conclusion, the treatment ($T_5$) 75% RDF + Soluble phosphorus 4 ml/L, exhibited the best performance in terms of yield and phosphorus use efficiency followed by ($T_4$) 75% RDF + Soluble phosphorus 3 ml/L. These results indicate that the application of solubilized phosphorus, in conjunction with reduced fertilizer dosage, can effectively enhance rice growth and productivity.

## FUTURE SCOPE

The following are some potential areas of future scope based on the study:

**1. Further Research Focus:** Investigate long-term effects of solubilized phosphorus on soil health, considering diverse environmental conditions for broader applicability.

**2. Optimization Studies:** Explore optimal dosage variations and application methods for solubilized phosphorus to maximize crop yield and minimize environmental impact.

**3. Economic Viability Analysis:** Conduct cost-benefit assessments to determine the financial feasibility and scalability of integrating solubilized phosphorus in rice cultivation practices.

**4. Adaptation in Farming Practices:** Develop guidelines and recommendations for farmers to effectively incorporate solubilized phosphorus into existing rice cultivation methods for enhanced productivity.

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**Conflict of interest.** None.

## REFERENCES

Avinash, B., Banerjee, M., Duvvada, S. K., Paul, S. K. and Malik, G. C. (2023). Response of Rice (*Oryza sativa* L.) varieties to Nutrient Management in kharif Season under Lateritic Soil of West Bengal. *Biological Forum – An International Journal, 15*(8), 326–333.

Bhattacharya, H. and Chatterjee, S. (1978). Effect of planting geometry and different levels of nitrogen on hybrid rice. *Oryza*, *48*(3), 274-275.

Hussain, Z., Khan, M. B., Ahmad, P. and Ibrahim, M. (2020). Foliar application of p-solubilizing bacteria and P-fertilizers individually and in combination affects rice productivity and sustainability. *Ecotoxicology and Environmental Safety*, *198*, 110581.

Irfan, M., Aziz, T., Maqsood, M. A. Bilal, H. M., Siddique, K. H. and Xu, M., (2020). Phosphorus (P) use efficiency in rice is linked to tissue-specific biomass and P allocation patterns. *Scientific reports*, *10*(1), pp.1-14.

Jat, R. K., Yadav, A., Duhan, S. and Punia, S. S. (2014). Effect of fertigation and foliar feeding of nutrients on yield, water use and economics of basmati rice (*Oryza sativa*)-wheat (*Triticum aestivum*) cropping system. *Indian Journal of Agronomy*, *59*(2), 286-291.

Kumar, G. S., Kumar, R. M., Srinivas, A., Jayasree, G. and Ramesh, T. (2022). Evaluation of Systems of Cultivation and Nutrient Management Practices on Yield Attributing Characters and Yield of Rice. *Biological Forum – An International Journal*, *14*(3), 986-994.

Mangera, Y. and Ekowati, N. Y. (2022). Analysis of the Nutrient content of liquid organic fertilizer (POC) household organic waste in Rimba Jaya Village, Merauke regency using the stacked bucket method. *Journal of Tropical Crop Agronomy*, *4*(1), 206– 214.

Raden, I., Fathillah, S. S. Fadli, M. and Suyadi, S. (2017). Nutrient content of liquid organic fertilizer (LOF) by various bio activator and soaking time. *Nusantara Bioscience*, *9*(2), 209-213.

Tandon, H. L. S. (1987). Phosphorus Research and Agricultural Production In India. FDCO, New Delhi. P: 50-120.

Teli, N. A., Bhat, M. A., Hussain, A., Ahangar, M. A., Ganaie, M. A. and Jehangir, I. A. (2018). Response of High Valued Scented Rice to Integrated Nutrient Management under Temperate Agro Climatic Conditions. *International Journal of Current Microbiology and Applied Sciences, 7*(3), 3496-3502.

Vance, C. P., Uhde-Stone, C. and Allan, D. L. (2003). Phosphorus acquisition and use: critical adaptations by plants for securing a nonrenewable resource. *New Phytol*, *157*, 423-447.

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