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# Relative efficiency of Jhabua rock phosphate along with single super phosphate, farmyard manure and phosphobacteria on rice (Co 43) dry matter production, yield parameters and yield

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**Abstract :** The investigation was carried out to study the effect of Jhabua rock phosphate (JRP) in combination with single superphosphate (SSP), farmyard manure (FYM) and phosphobacteria (PB) on yield parameters and yield of rice crop (Co 43) in clayloam soil. Combined application of JRP and SSP in 1:1 ratio along with FYM (12.5 t $ha^{-1}$) and PB significantly increased the drymatter production, yield (straw and grain) and yield parameters like number of productive tillers per hill, number of filled grains per panicle, panicle length and thousand grain weight over application of 100 per cent JRP alone but comparable with application of 100 per cent SSP alone.

*Keywords : Jhabua rock, phosphate, Phosphobacteria and Dry matter production.*

## Introduction

Phosphorus is one of the critical nutrient element for increasing the crop growth and yield. Single superphosphate being a source of water soluble P fertilizer, reacts with Al and Ca ions and their oxides and hydroxides in soil and form insoluble phosphates which are unavailable to the plant. Hence, attempts are being made to utilize the indigenous RP as an alternate source of phosphatic fertilizer for direct application. However, direct application of rock phosphate to non-acid soil is not considered as a suitable practice. Under this condition, the P use efficiency of rockphosphate (RP) can be increased by the combined application of water soluble P fertilizer, organic manures and biofertilizers. Ramasamy and Rani Perumal (1980) reported that the treatments super phosphate (SP) (100%) and the combination of SP (25%), Mussooriephos (75%) and FYM produced similar grain yield in case of rice crop. The present study was undertaken to investigate the effect of Jhabua rock phosphate (JRP) in combination with single super phosphate (SSP), farmyard manure (FYM) and phosphobacteria (PB) on yield, DMP and yield parameters of rice crop.

## Materials and Methods

A field experiment was conducted in Vertic Ustochrept of wetland, Tamil Nadu Agricultural University, Coimbatore with rice var. Co 43 as a test crop during late samba season of 2000-2001. The soil of the experimental site was clay loam in texture with pH 8.4, EC 0.4 $dSm^{-1}$, OC 0.82 per cent and CEC 29.8 c mol ($p^+$) $kg^{-1}$, the available N, P and K content were 226.8, 16.0 and 368.0 kg $ha^{-1}$ respectively. The experiment was laid out in a randomized block design with 14 treatments and three replications.

The treatments consisted of, $T_1$ - Control; $T_2$ - SSP recomended dose as per crop production guide (CPG) (50 kg $P_2O_5$ $ha^{-1}$) ; $T_3$ - JRP (50 kg $P_2O_5$ $ha^{-1}$) ; $T_4$ - $T_3$ + Phosphobacteria (PB) (seed treatment 600 g $ha^{-1}$ seeds), seedling treatment (2 kg in 12 l water) and soil application (2 kg $ha^{-1}$) ; $T_5$ - $T_3$ + Farm yard manure (FYM) (12.5 t $ha^{-1}$) ; $T_6$ - $T_5$ + PB (seed treatment 600 g $ha^{-1}$ seeds), seedling treatment (2 kg in 12 l water) and soil application (2 kg $ha^{-1}$) ; $T_7$ - 75% JRP + 25% SSP ; $T_8$ - $T_7$ + PB (seed treatment 600 g $ha^{-1}$ seed), seedling treatment (2 kg in 12 l water) and soil application (2 kg $ha^{-1}$); $T_9$ - $T_7$ + FYM (12.5 t $ha^{-1}$) ; $T_{10}$ - $T_9$ + PB (seed treatment 600 g $ha^{-1}$ of seeds), seedling treatment (2 kg in 12 l. of water) and soil application (2 kg $ha^{-1}$); $T_{11}$ - 50% JRP + 50% SSP ; $T_{12}$ - $T_{11}$ +PB (seed treatment 600 g $ha^{-1}$ seeds), seedling treatment (2 kg in 12 l. water) and soil application (2 kg $ha^{-1}$); $T_{13}$ -$T_{11}$ + FYM (12.5 t $ha^{-1}$) ; $T_{14}$ - $T_{13}$ + PB (seed treatment 600 g $ha^{-1}$ seeds), seedling treatment (2 kg in 12 l water) and soil application (2 kg $ha^{-1}$).

Phosphobacteria seed treatment was given by soaking the seeds (600 g $ha^{-1}$ seeds) in water for overnight. The excess water was poured over the nursery area itself.

Rice seedling roots were dipped and kept in PB slurry (2 kg PB dissolved in 12 l of water) for 30 minutes. Then, the seedling treated

Table 1. Effect of treatments on DMP and yield parameters of rice.

| Treatments | DMP (kg ha$^{-1}$) | Productive tillers hill$^{-1}$ | Panicle length (cm) | 1000 grain weight (g) | No.of filled grains panicle$^{-1}$ |
|---|---|---|---|---|---|
| $T_1$ - Control | 5575.75 | 7.33 | 19.90 | 19.59 | 80.80 |
| $T_2$ - 100 % SSP | 6304.50 | 12.32 | 26.57 | 21.84 | 134.50 |
| $T_3$ - 100 % JRP | 5699.75 | 7.67 | 22.22 | 20.30 | 96.50 |
| $T_4$ - $T_3$ + PB | 5722.00 | 8.33 | 22.77 | 20.40 | 97.70 |
| $T_5$ - $T_3$ + FYM | 5729.25 | 8.67 | 23.33 | 20.17 | 96.30 |
| $T_6$ - $T_5$ + PB | 5773.75 | 9.33 | 23.77 | 20.50 | 97.70 |
| $T_7$ - 75 % JRP + 25 % SSP | 5839.25 | 8.67 | 24.13 | 20.50 | 100.00 |
| $T_8$ - $T_7$ + PB | 5896.50 | 9.33 | 24.30 | 20.60 | 102.30 |
| $T_9$ - $T_7$ + FYM | 5960.50 | 9.67 | 24.30 | 21.18 | 103.80 |
| $T_{10}$ - $T_9$ + PB | 6198.00 | 1067 | 24.30 | 21.38 | 108.80 |
| $T_{11}$ - 50 % JRP + 50 % SSP | 6057.50 | 9.67 | 23.44 | 21.30 | 103.30 |
| $T_{12}$ - $T_{11}$ + PB | 6221.75 | 10.67 | 24.67 | 21.46 | 114.50 |
| $T_{13}$ - $T_{11}$ + FYM | 6269.25 | 12.33 | 25.67 | 21.64 | 128.80 |
| $T_{14}$ - $T_{13}$ + PB | 6707.26 | 14.33 | 28.50 | 22.10 | 158.80 |
| CD (P= 0.05) | 116.33 | 0.33 | 0.76 | 0.91 | 2.09 |

Table 2. Effect of treatments on straw and grain yield, straw grain ratio and PUE

| Treatments | Straw yield (kg ha$^{-1}$) | Grain yield (kg ha$^{-1}$) | Straw grain ratio (kg kg$^{-1}$) | PUE |
|---|---|---|---|---|
| $T_1$ - Control | 7825 | 4340 | 1.80 | - |
| $T_2$ - 100 % SSP | 8025 | 6040 | 1.33 | 34.00 |
| $T_3$ - 100% JRP | 7838 | 4425 | 1.77 | 1.70 |
| $T_4$ - $T_3$ + PB | 7844 | 4488 | 1.75 | 2.96 |
| $T_5$ - $T_3$ + FYM | 7850 | 4513 | 1.74 | 3.38 |
| $T_6$ - $T_5$ + FYM | 7849 | 4628 | 1.70 | 5.76 |
| $T_7$ - 75 % JRP + 25 % SSP | 7928 | 4745 | 1.67 | 8.10 |
| $T_8$ - $T_7$ + PB | 7966 | 4885 | 1.63 | 10.90 |
| $T_9$ - $T_7$ +FYM | 7976 | 5080 | 1.57 | 14.80 |
| $T_{10}$ - $T_9$ + PB | 7989 | 5987 | 1.33 | 32.92 |
| $T_{11}$ - 50 % JRP +50 % SSP | 7978 | 5482 | 1.46 | 22.84 |
| $T_{12}$ - $T_{11}$ + PB | 7993 | 5963 | 1.34 | 32.46 |
| $T_{13}$ - $T_{11}$ + FYM | 8017 | 5997 | 1.33 | 33.14 |
| $T_{14}$ - $T_{13}$ + PB | 9250 | 6129 | 1.51 | 35.78 |
| CD (P=0.05) | 202.63 | 177.09 | 0.087 | 3.55 |

with and without PB were transplanted in their respective plots with a spacing of 20cm x 10 cm.

PB @ 2 kg ha$^{-1}$ was applied after mixing with sand to those plots as per the treatment. The FYM application was done at the begining @ 12.5 t ha$^{-1}$ for those plots as per the treatment schedule and incorporated in the soil.

The observations like panicle length, number of tiller hill$^{-1}$, number of filled grains panicle$^{-1}$ and 1000 grain weight were recorded during harvest stage. The dry matter production (DMP), straw and grain yields were recorded. The phosphorus use efficiency and straw grain ratio were calculated.

$$PUE = \frac{Ydt - Ydc}{Pa} \times 100$$

where,

PUE = Phosphorus use efficiency (kg of grain produced per kg of $P_2O_5$ applied)

Ydt = Yield in treated plot (kg ha$^{-1}$)

Yldc = Yield in control plot (kg $ha^{-1}$)
Pa = Phosphorus applied (kg $P_2O_5$ $ha^{-1}$)

## Results and Discussion

*(i) DMP and Yield parameters*

The treatment had significant effect on DMP. It ranged from 5575.75 to 6707.26 kg $ha^{-1}$ for overall stages (Table 1). The treatment consisting of JRP and SSP (1:1) along with FYM and PB ($T_{14}$) registered the highest DMP (6707.26 kg $ha^{-1}$) followed by the application of 100 per cent SSP alone ($T_2$) (6304.5 kg $ha^{-1}$). The highest DMP in $T_{14}$ treatment might be due to the increased P availability resulted from the readily soluble nature of SSP and the increased dissolution of JRP by organic acids released during decomposition of FYM and due to the P solubilizing nature of PB (Dhanasekaran, 2000). There was a positive correlation between soil available phosphorus and dry matter production (r=0.828**).

The treatment $T_{14}$ registered the highest number of productive tillers $hill^{-1}$, number of filled grains, panicle length and 1000 grain weight were 14.33, 158.8, 28.5 cm and 22.1 g respectively (Table 1). It was followed by the treatment $T_2$ with respect to the number of productive tillers $hill^{-1}$ (12.32), number of filled grains $panicle^{-1}$ (134.5) and panicle length (26.57 cm) of rice crop. The treatment $T_{14}$ was on par with the treatments $T_2$, $T_{13}$, $T_{12}$, $T_{10}$ and $T_{11}$ with respect to the thousand grain weight (21.84, 21.64, 21.46, 21.38 and 21.3 respectively) (Table 1).

The highest number of productive tillers $hill^{-1}$, number of filled grains $panicle^{-1}$, panicle length and 1000 grain weight in $T_{14}$ treatment might be due to the highest available P, resulted in rapid root proliferation which reflected in growth and tillering ability. This is in accordance with the findings of Paulraj and Velayudham (1995) and Dhanasekaran (2000).

*(ii) Straw and grain yield, straw grain ratio and PUE*

The data in Table 2 indicated that the maximum grain yield (6129 kg $ha^{-1}$) obtained with the combined application of 100 per cent SSP alone (6040 kg $ha^{-1}$) and application of 1:1 JRP and SSP with FYM (5997 kg $ha^{-1}$) or with PB (5963 kg $ha^{-1}$). This is in line with the findings of Rani Perumal *et al.* (1994) and Dhanasekaran (2000). The highest straw yield was obtained by the treatment $T_{14}$ (9250 kg $ha^{-1}$) (Table 2). The highest yield in $T_{14}$ treatment might be due to (i) dissolution effect of organic manures on rock phosphate (ii) release of nutrients from decomposition of organic manures themselves (iii) increased available P due to the application of phosphorus solubilizing bacteria (PB) as suggested by Prakash and Badrinath (1995).

Application of 1:1 JRP and SSP along with FYM and PB recorded the highest PUE (35.78 $kg^{-1}$) followed by 100 per cent SSP alone (34.0 $kg^{-1}$) (Table 2). This might be due to the incorporation of FYM in soil and inoculation of PB which could have enhanced the solubilization of added as well as native P and inturn increased the P availability in soil and resulted in higher PUE. The maximum straw grain ratio was observed in control plot ($T_1$) (1.8) (Table 2). This aligns with the earlier findings of Dhanasekaran (2000).

From the results, it was concluded that the application of 1:1 JRP and SSP along with FYM and PB significantly increased the DMP, yield and yield parameters of rice crop.

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