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# Effect of silica and phosphorous application on growth and yield of rice

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## Abstract
The field experiment conducted to study the impact of phosphorous and silica application on growth and yield of rice in submerged condition. The experiment was laid out in factorial randomized block design with four levels of phosphorous (0, 25, 50 and 75 kg ha$^{-1}$) and four levels of silica (0, 50, 100 and 150 kg ha$^{-1}$) replicated thrice. The highest straw and grain yield (56.0 and 42.75 q ha$^{-1}$ respectively) of rice obtained by sole and combine application of phosphorous @ 75 kg ha$^{-1}$ along with silica @ 150 kg ha$^{-1}$ and influenced significantly. The maximum numbers of tillers and panicles as well as plant height was recorded by application of phosphorous @ 75 kg ha$^{-1}$. Silica application @ 150 kg ha$^{-1}$ noticed to be increasing tillers, panicles and plant height. Thus application of phosphorous @ 75 kg ha$^{-1}$ along with Silica @ 150 kg ha$^{-1}$ is effectively improved growth and yield of rice.

**Keywords:** Silica, phosphorous, rice, yield and growth

## Introduction
Rice is considered as most important staple crop in many countries. Due to imbalance use of fertilizer, disease incidence and low moisture adaptability the yield of rice is declining (Prakash, 2010) [13]. It has been found that, due to several constraints in laterite soils, the rice productivity is to be low. On the other hand, through proper land and nutrient management there is considerable scope for improving the productivity of rice.

Silicon is second most abundant element in earth crust; although it is found to be poor availabile in soil due to its insoluble silicates. The monosilicic acid ($H_4SiO_4$) is the available form of Si in soil and which is absorbed by plants in tissue, ranged from 0.1 to 10%. Silicon being not recognized as a “Essential nutrient’ but which plays an important role in the development and growth of crops particularly rice and sugarcane (Epstein 1999) [4].

Rice is the high silicon accumulating plant. Beyond the rice yield increment, Si shows many advantages such as increasing availability of primary secondary and micro nutrients. In addition to that, silicon in rice minimizes biotic and abiotic stress. Ahmad *et al*., 2013 [2] reported that Silicon application enhances yield, yield attributes, quality and growth parameters of rice. Thus silicon application to soil and plant is essential for improving and sustaining rice productivity in lateritic paddy soils of konkan.

Phosphorus is the second major plant nutrient after nitrogen. It plays a important role in several physiological processes such as photosynthesis, energy storage, respiration, and cell division as well as enlargement. It is also an important structural component of many biochemicals *viz* DNA, RNA, enzymes and coenzymes. Phosphorous application stimulates root growth and associated with early maturity of crops. It offers increased disease resistance to plants and prevents from lodging by providing strength to straw.

One reason for lower yield of rice is lower P content in the Indian soil. The 60% soils are low to medium in available P (Motsara, 2002) [10]. Added inorganic P as water soluble phosphate fertilizer undergoes complex exchanges between various soil-P pools. This is especially true in the tropics where many soils have extremely high P fixation capacity. Consequently, large amounts of fertilizer P are needed to attain reasonable crop yields. Since the utilization of phosphate fertilizer is very low (10-30%) and its availability increases under submerged conditions (Nadeem and Ibrahim 2002) [11]. Therefore it is very important to manage properly for achieving of maximum benefit especially under submerged condition where P availability increases (Terman *et al*., 1970) [18]. Phosphorous application influence early tillering and vigorous root development of plants. Si and P may be the potential nutrient to cope up the effect of water stress in aerobic rice and enhance its productivity.

The emerging scenario necessitates the need for adoption of the practices which helps in maintaining soil health, keeps the rice production sustainable and provides qualitative food for meeting the nutritional requirement of human beings. Moreover, the effect of Si and P on aerobic rice has not been explored. Considering these facts in view, the current study was initiated to determine the effect of silicon and phosphorus fertilization on growth, productivity and profitability of aerobic rice.

## Material and Methods

The field experiment was conducted at experimental farm of Department of Soil Science and Agricultural Chemistry, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli. The study area is located at $17^0$ 45' 02" North latitude and $73^0$ 10' 55" East longitude. The area falls under 19.2 Agro-ecological sub-region (AESR) i.e., central and south sahyadris region represented by hot moist sub humid to humid transitional ecological sub-region (ESR).

The experiment was laid out in factorial randomized block design with fifteen treatment combinations and three replications. The factor consisted four levels of each phosphorous and silica. The phosphorous was applied at the rate of 0, 25, 50 and 75 kg $ha^{-1}$, whereas, the silica was applied at 0, 50, 100, and 150 kg $ha^{-1}$, respectively. The recommended dose of rice for primary nutrients i.e. 100:50:50 $N:P_2O_5:K_2O$ was applied through straight fertilizers *viz*. urea, SSP and MOP. The whole dose of the phosphorous and potassium was applied at the time of transplanting and nitrogen in two split doses at the time of transplanting and tillering stage respectively. The silica was applied at prior to the transplanting through potassium silicate containing 52 per cent silica.

The Ratnagiri-24 variety of rice was used as test crop. Puddling was carried out in the experimental plot to prior to the transplanting of rice. The 25 days old healthy seedlings prepared was used for transplanting of rice. Seeds of the rice were treated with thirum to exclude any fungal disease infestation. General cultural operations like weeding, spraying of the fungicides and insecticides was conducted during the growing season. The mean annual rainfall is 3500 mm, of which about 90 per cent is received during the months of June to October. Generally total 95 to 100 rainy days are in the most of years. The prominent rainfall in the region is responsible for cultivation of rice in most of the area.

The observations like numbers of tillers, effective tillers and plant height were recorded at 30 days after transplanting, 60 days after transplanting and at harvest stage respectively. The rice was harvested when it was physiologically mature; dried in the sunlight and recorded for grain and straw yield.

The experimental data was analyzed statistically by the technique of analysis of variance as applicable to factorial randomized block design. The significance of treatment difference was tested by "F" (Variance ratio) test. Critical difference (C.D.) at 5 per cent level of probability was worked out for comparison and statistical interpretation of the treatment means. (Panse and Sukhatme, 1967) [12]

## Result and Discussion

### Plant Height

The application of the phosphorous was noticed to be significant with respect to plant height of rice. The application of the phosphorous @ 75 kg $ha^{-1}$ recorded maximum plant height (41.30 cm, 82.45 cm and 84.60 cm) at 30 DAT, 60 DAT and at harvest, respectively. Amongst all the silica levels, the highest application of silica @ 150 kg $ha^{-1}$ recorded significantly highest plant height (42.46 cm, 81.40 cm and 83.43 cm), at 30 DAT, 60 DAT and harvest stage, respectively. (42.46 cm, 81.40 cm and 83.43 cm). The interaction effect between phosphorous and silica application found to be significant as treatment combination $P_3Si_3$ indicating 75 Kg P $ha^{-1}$ along with silica @ 150 kg $ha^{-1}$ recorded maximum plant height (42.88 cm 82.94 cm and 85.01 cm) at 30 DAT, 60 DAT and at harvest stage.

It was revealed from data (Table 1 and table 2) the increasing rates of both phosphorous and silica improves plant height and was maximum at highest rate. Rice plant adequately supplied with phosphorous enhance photosynthetic activities and accumulation of the photosynthates which result in more plant height (Sarkar *et al*., 2018) [15]. The results were tune with Khan *et al*. (2017) [6]. The application of silica make rice plant and leaves erect and possibly increase height; reported by Mahzoor *et al*., 2006 [8]. The increasing height of rice by silicon application also reported by Meena *et al*., (2014) [9] and Aarekar *et al*., (2014) [1].

### Number of tillers and Effective tillers

The application of phosphorus recorded significant result with respect to number of tillers. The highest level of phosphorous application (75 kg P $ha^{-1}$) showed significantly maximum tillers at 30 DAT, 60 DAT and at harvest stage respectively (6.19, 9.33 and 8.97). Similarly the highest silica application consisting silica @ 150 kg $ha^{-1}$ reported to be significant and highest regarding the number of tillers (5.68, 8.82, and 8.36 for 30 DAT, 60 DAT and at harvest respectively). However, the interaction between phosphorous and silica application did not reach the level of significance at all growth stages. Whereas, the maximum numbers of effective tillers was achieved by highest application of the phosphorous as well as silica.

**Table 1:** Effect of phosphorous levels on plant height, number of tillers and number of panicles at various growth stages.

| Treatment | Plant height (cm) | | | Number of tillers | | | Numbers of panicle | Grain yield | Straw yield |
|---|---|---|---|---|---|---|---|---|---|
| | 30 DAT | 60 DAT | At Harvest | 30 DAT | 60 DAT | At Harvest | | | |
| $P_0$ - 0 kg $ha^{-1}$ | 38.36 | 78.36 | 80.49 | 4.52 | 7.56 | 7.06 | 6.26 | 31.48 | 38.34 |
| $P_1$ - 25 kg $ha^{-1}$ | 39.78 | 79.78 | 81.91 | 4.97 | 8.01 | 7.51 | 6.71 | 35.09 | 43.71 |
| $P_2$ - 50 kg $ha^{-1}$ | 41.35 | 81.51 | 83.48 | 5.96 | 8.99 | 8.59 | 7.79 | 37.62 | 47.49 |
| $P_3$ - 75 kg $ha^{-1}$ | 42.46 | 82.45 | 84.60 | 6.19 | 9.33 | 8.97 | 8.17 | 39.94 | 51.64 |
| S.Em. (±) | 0.08 | 0.09 | 0.08 | 0.17 | 0.12 | 0.13 | 0.13 | 0.213 | 0.265 |
| C.D. at 5% | 0.23 | 0.26 | 0.23 | 0.49 | 0.37 | 0.38 | 0.38 | 0.616 | 0.767 |

**Table 2:** Effect of silica levels on plant height, number of tillers and number of panicles at various growth stages.

| Treatment | Plant height (cm) | | | Number of tillers | | | Numbers of panicle | Grain yield | Straw yield |
|---|---|---|---|---|---|---|---|---|---|
| | 30 DAT | 60 DAT | At Harvest | 30 DAT | 60 DAT | At Harvest | | | |
| $Si_0$ - 0 kg $ha^{-1}$ | 39.58 | 79.58 | 81.71 | 5.00 | 8.03 | 7.58 | 6.78 | 34.85 | 43.22 |
| $Si_1$ - 50 kg $ha^{-1}$ | 40.32 | 80.30 | 82.45 | 5.41 | 8.45 | 8.00 | 7.20 | 35.35 | 44.17 |
| $Si_1$- 100 kg $ha^{-1}$ | 40.76 | 80.82 | 82.89 | 5.56 | 8.59 | 8.19 | 7.39 | 36.66 | 46.26 |
| $Si_3$ - 150 kg $ha^{-1}$ | 41.30 | 81.40 | 83.43 | 5.68 | 8.82 | 8.36 | 7.56 | 37.27 | 47.52 |
| S.Em. (±) | 0.08 | 0.09 | 0.08 | 0.17 | 0.12 | 0.13 | 0.13 | 0.213 | 0.265 |
| C.D. at 5% | 0.23 | 0.25 | 0.23 | 0.49 | 0.36 | 0.37 | 0.37 | 0.607 | 0.755 |

Sufficient phosphorus supply along with other nutrients was useful for efficient utilization of the nutrients; which results cell multiplication, enlargement and formation of nucleic acids as well as other vital important organic compounds in the cell sap (Simons, 1982) [16].

Higher dry matter production was associated by the highest dose of silica i.e. @ 175 kg $ha^{-1}$ which might be due to highest photosynthetic activity by higher photosynthesizing area (Rani *et al*., 1997) [14]. Also Ma *et al.*, 1989 [7] reported to erectness of leaves improves penetration of sunlight which leads to increases photosynthesis of plant and carbohydrate formation.

## Grain and Straw Yield

Grain and straw yield of the rice was significantly influenced by the application of the phosphorous and silica. The highest grain as well as straw yield was obtained by the treatment $P_4$ and $Si_4$ consisted application of phosphorous @ 75 kg $ha^{-1}$ and silica @ 175 kg $ha^{-1}$, respectively. Higher yields achieved by higher levels of phosphorus might be due to better root growth and increased uptake of nutrients by rice. Application of phosphorus improves in leaf photosynthetic rate, biomass production and sink formation which able to increases grain yield of rice (Archana *et al*., 2016) [3]. Wang *et al.* (2014) [19] reported that Application of silicate fertilizers increases the percentage of ripened grains in rice and contribute towards the decrease in the numbers of blank spikelet and to increase filled spikelet percentage (Wang *et al*., 2014; Fallah *et al*., 2004) [19, 5]. The results are tune with Talashilkar *et al*. (1996) [17].

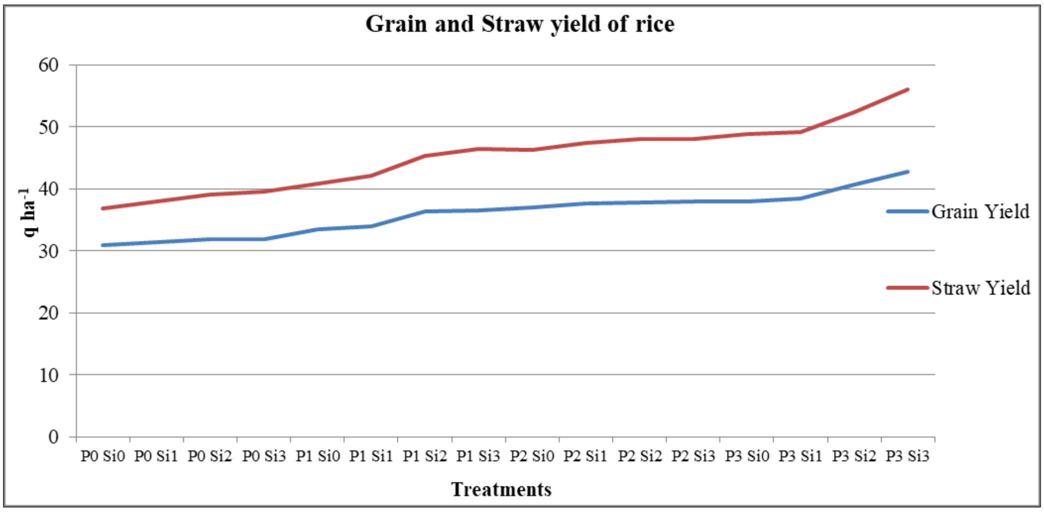


**Fig 1:** Effect of different treatment combination on grain and straw yield (q $ha^{-1}$) of rice.

## Conclusion

Amongst the different levels of phosphorus application, the application of 75 kg $ha^{-1}$ phosphorous through SSP was found to be promising source of phosphorus fertilizers and superior for increasing rice yield and yield attributing characters. The Application silica @ 150 kg $ha^{-1}$ was reported to be enhanced the yield and yield attributing character of rice. Hence combine application of phosphorous @ 75 kg $ha^{-1}$ and silica @ 150 kg $ha^{-1}$ was effective for yield and growth of rice.

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