

Use of Vivianite obtained from Water Purification as Phosphorus Fertilizer

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Background of Study

Phosphorus (P) is an essential macronutrient required by crops for optimum growth. The world reserve of phosphate rock is constantly declining both in quantity and quality. Hence there is a need for alternative sources of P fertilizers to sustain crop production and ensure global and future food security.

Vivianite, an iron phosphate mineral $Fe_3(PO4)_2.8H_2O$ contains an average of 32% Fe and 10% P and can be obtained through P removal in water purification. It has proved to be an effective Fe fertilizer for overcoming Fe deficiency in calcareous soils. However little or no information exist about its potential use as P fertilizer.



Fig. 1: Cross section of just transplanted wheat seedlings



Materials and Methods

P-TR

Two Mediterranean soil samples (one calcareous and the other non-calcareous) with low Olsen P content (< 8mg kg⁻¹) were used for a pot experiment with wheat plant.

□ Fertilizer products - 3 types of vivianite, 2 types of struvite and $Ca(H_2PO)_{4.}H_2O(Soluble P)$ was used as a source of P fertilizer.

The objective of the study was to assess the potential of vivianite as a P fertilizer relative to soluble mineral P fertilizer (superphosphate) and struvite which is recognized as a poorly soluble source of P.



Fig. 2 : Cross section of growing wheat plants in the growing chamber.

The potential of vivianite to be used as a source of P fertilizer was not positive in this study.

Soluble P fertilizers and struvite were the most effective fertilizer product in this study. □ The growing media was prepared by mixing fertilizer products with 300g of soils and placed in cylindrical plastic pots of 350ml volume, 15cm height and diameter of 5.5cm. All fertilizers were tested at two rates (50 and 100 mg P kg⁻¹).

The wheat plants were harvested 51 days after transplanting. Bulk soil samples were also collected to determine the Olsen P value of the soils after the experiment.

Calcareous Soil

Fig. 3: Effect of different fertilizer treatment on total plant biomass production (P applied at two rates: 50 and 100 mg P kg⁻¹). Tukey HSD p < 0.05

C-Control; PCH-Soluble P fertilizer; SA-Struvite 1; SB-Struvite 2; SV-Synthetic Vivianite; VA-Water Purification Vivianite 1; VB-Water Purification Vivianite 3; VF-Industrial effluents Vivianite

□The soluble P fertilizer and the two struvites yielded the highest plant biomass after the experiment with no significant difference between the 3 in both soils. Between vivianites, the highest yield was obtained from the synthetic vivianite and the one from industrial effluents. The yield was higher in all treatments in Calcareous



Fertilizer Treatment

Fig. 4: Effect of different fertilizer treatment on total P conc. in plants (P applied at two rates: 50 and 100 mg P kg⁻¹). Tukey HSD p <0.05

C-Control; PCH-Soluble P fertilizer; SA-Struvite 1; SB-Struvite 2; SV-Synthetic Vivianite; VA-Water Purification Vivianite 1; VB-Water Purification Vivianite 3; VF-Industrial effluents Vivianite

Conclusion



Fertilizer Treatment

Fig. 5: Effect of different fertilizer treatment on Olsen P in soils after harvesting (P applied at two rates: 50 and 100 mg P kg⁻¹). Tukey HSD p <0.05

C-Control; PCH-Soluble P fertilizer; SA-Struvite 1; SB-Struvite 2; SV-Synthetic Vivianite; VA-Water Purification Vivianite 1; VB-Water Purification Vivianite 3; VF-Industrial effluents Vivianite

UThe Olsen Ρ after harvest was significantly Soluble higher Ρ IN fertilizer when compared with all other treatments at both rates of fertilizer application in both soils. Synthetic and industrial effluents vivianite were the only vivianites that increased Olsen P in soils after harvest.



The Concentration of Total P in plants after harvesting was observed to be highest in soluble P fertilizer at the two rates of P fertilizer application in both soils.

Struvites yielded similar plant biomass when compared with soluble P fertilizer and were higher than all vivianites at both rates. The best performance with vivianites was recorded with the synthetic vivianite and vivianite from industrial effluents.



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