Impact of Zeolite and Soil Moisture on P Uptake

Amirhossein Shokouhi, Masoud Parsinejad and Hamidde Noory
University of Tehran, Iran.
shokouhi.amir@ut.ac.ir

1. ABSTRACT

Importance of phosphorus as an essential nutrient for plant growth, limitations on sources of phosphate rock and inherent characteristics of phosphorus fixation and immobility, demonstrates the need of study on strategies to increase phosphorus plant uptake and reduce leaching. In this study, effect of NH4-exchanged Zeolite (Clinothilitol) to reduce the fixation time and increase availability of phosphorus due to its chemical characteristics in combination with two levels of soil moisture (40 and 50 percent depletion) was evaluated. In addition, macronutrients were artificially introduced in soil to observe the effect of the management strategies under a condition prone to leaching. Results demonstrated that addition of Zeolite at 2 percent weight of soil (as source of phosphorus uptake), has a significant increase in phosphorus uptake to achieved under a higher rate of Zeolite/soil is introduced. This latter option may not necessarily be economically justified. Also, the results show that increased average soil moisture could increase rate of phosphorus uptake quantitatively. Finally, artificial macronutrients facilitate redistribution of contents in soil which was resulted in a better root growth which improved phosphorus uptake.

2. INTRODUCTION

Phosphorus is the second most essential nutrient for plants growth after nitrogen. The great importance of phosphorus is because of the role it plays in the biochemical and physiological processes. On the other hand, phosphorus due to its limited resources is highly important. Due to the limited resources of phosphorus rock, optimal and proper utilization of the cycle of using this element is essential. Phosphorus uptake by plants depends on factors such as soil pH, soil texture, and systems of root development. Phosphorus uptake has some problems due to the high rate of fixation, low dissolution, and abundance of this element in the soil. Therefore, this problem generally high amount of phosphorus fertilizer in agricultural land. Excessive use of phosphorus fertilizer creates problems such as the extraction of phosphorus into surface waters and creation of a phenomenon of the enrichment of surface waters (Eutrophication).

The most suitable soils for absorption of phosphorus have been reported to be the lands with pH near to 7.5. Another important factor in the absorption of phosphorus in fishes is moisture. With increasing soil moisture, phosphorus uptake by plants generally increases, the reason of which is higher solubility of phosphorus and physiological processes. On the other hand, phosphorus due to its limited availability and physiological processes, demonstrate the need of study on strategies to increase phosphorus plant uptake. Phosphorus uptake by plants depends on factors such as soil pH, soil texture, and systems of root development. Phosphorus uptake has some problems due to the high rate of fixation, low dissolution, and abundance of this element in the soil. Therefore, this problem generally high amount of phosphorus fertilizer in agricultural land. Excessive use of phosphorus fertilizer creates problems such as the extraction of phosphorus into surface waters and creation of a phenomenon of the enrichment of surface waters (Eutrophication).

The most suitable soils for absorption of phosphorus have been reported to be the lands with pH near to 7.5. Another important factor in the absorption of phosphorus in fishes is moisture. With increasing soil moisture, phosphorus uptake by plants generally increases, the reason of which is higher solubility of phosphorus and physiological processes. On the other hand, phosphorus due to its limited availability and physiological processes, demonstrate the need of study on strategies to increase phosphorus plant uptake. Phosphorus uptake by plants depends on factors such as soil pH, soil texture, and systems of root development. Phosphorus uptake has some problems due to the high rate of fixation, low dissolution, and abundance of this element in the soil. Therefore, this problem generally high amount of phosphorus fertilizer in agricultural land. Excessive use of phosphorus fertilizer creates problems such as the extraction of phosphorus into surface waters and creation of a phenomenon of the enrichment of surface waters (Eutrophication).

Surface irrigation was applied for each pot according to the moisture depletion and in order to prevent soil moisture from reaching the minimize level. Deep irrigation was applied for the marginal plants with regard to the need for irrigation calculated by the software AGUINE. The moisture was used on a dial basis using TDH device and 30 cm depths. Taking the soil sample of the pots was conducted before the flowering stage. Soil samples were taken from the bottom of each pot with a depth of 20 and 40 cm using larger digging. Olsen method was used to measure the concentration of residual phosphorus in soil. Extraction was performed on soil samples and resulted phosphorus concentration of soil extraction was carried out by 6789 UV/visible spectrophotometer (undermetric method). Extraction was performed on plant samples to determine the amount of phosphorus uptake by the plant, and phosphorus concentration of plant extraction was determined by spectrophotometer. With regard to the weight of aerial plant organ, phosphorus concentration (mg/kg) was converted into absorbed phosphorus in mg/kg. The amount of phosphorus uptake by the root was also obtained from the phosphorus balance. In order to investigate the created density of root, at the end of the study, soil was washed off the roots. Analysis of variance for the measured traits was performed with SAS, and means of the targeted features were compared using Duncan’s test for comparison of means at level 5%.

4. RESULTS & DISCUSSIONS

By examining the volume of irrigation water, it can be seen that the treatments with 40 percent depletion level, received more water in terms of volume compared to the treatments with 50 percent moisture depletion level. However, analysis of variance of the volume of irrigation water, due to the limited size of the studied soil and non-significant difference of applied moisture levels in two depletion levels of 40% and 50%, did not show any statistically significant difference between the treatments. Comparing means of the treatment Duncan test at 5% level, indicated a reduction in the volume of the irrigation water in the presence of Zeolite, but such a difference was not significant compared to the absence of Zeolite (Figure 2).

Phosphorus is the second most essential nutrient for plants growth after nitrogen. The great importance of phosphorus is because of the role it plays in the biochemical and physiological processes. On the other hand, phosphorus due to its limited resources is highly important. Due to the limited resources of phosphorus rock, optimal and proper utilization of the cycle of using this element is essential. Phosphorus uptake by plants depends on factors such as soil pH, soil texture, and systems of root development. Phosphorus uptake has some problems due to the high rate of fixation, low dissolution, and abundance of this element in the soil. Therefore, this problem generally high amount of phosphorus fertilizer in agricultural land. Excessive use of phosphorus fertilizer creates problems such as the extraction of phosphorus into surface waters and creation of a phenomenon of the enrichment of surface waters (Eutrophication).

Surface irrigation was applied for each pot according to the moisture depletion and in order to prevent soil moisture from reaching the minimize level. Deep irrigation was applied for the marginal plants with regard to the need for irrigation calculated by the software AGUINE. The moisture was used on a dial basis using TDH device and 30 cm depths. Taking the soil sample of the pots was conducted before the flowering stage. Soil samples were taken from the bottom of each pot with a depth of 20 and 40 cm using larger digging. Olsen method was used to measure the concentration of residual phosphorus in soil. Extraction was performed on soil samples and resulted phosphorus concentration of soil extraction was carried out by 6789 UV/visible spectrophotometer (undermetric method). Extraction was performed on plant samples to determine the amount of phosphorus uptake by the plant, and phosphorus concentration of plant extraction was determined by spectrophotometer. With regard to the weight of aerial plant organ, phosphorus concentration (mg/kg) was converted into absorbed phosphorus in mg/kg. The amount of phosphorus uptake by the root was also obtained from the phosphorus balance. In order to investigate the created density of root, at the end of the study, soil was washed off the roots. Analysis of variance for the measured traits was performed with SAS, and means of the targeted features were compared using Duncan’s test for comparison of means at level 5%.

By examining the volume of irrigation water, it can be seen that the treatments with 40 percent depletion level, received more water in terms of volume compared to the treatments with 50 percent moisture depletion level. However, analysis of variance of the volume of irrigation water, due to the limited size of the studied soil and non-significant difference of applied moisture levels in two depletion levels of 40% and 50%, did not show any statistically significant difference between the treatments. Comparing means of the treatment Duncan test at 5% level, indicated a reduction in the volume of the irrigation water in the presence of Zeolite, but such a difference was not significant compared to the absence of Zeolite (Figure 2).

In general, by decreasing humidity, phosphorus uptake was reduced with a gande depth. The presence of artificial macronutrients, due to the high-density calibration which leads to consume all irrigation water by plant, could not behave as expected in accelerating preferential flow and forming drainage, and the effects of artificial macronutrients could only led to the redistillation of moisture in soil. The washed roots from the pots were equal to 40 to 65 cm, and based on the 40 cm height of soil in the pots, and two corn plants being placed in a pot with a diameter of 35 cm, these values totally point out the high density of planting that prevented the drainage to be formed and phosphorus deposits to be leached by the output drainage.

5. CONCLUSION

Low transferability, low solubility of phosphorus, as much as it is needed, still results in limited plant uptake. Although concerns about environmental pollution of phosphorus in much lower compared to nitrates, studies on management strategies to increase its plant uptake is still important, especially when potential risk of P-loads and environmental pollution is high. In this study field treatments were designed to examine the role of Clinoptilolite on increasing phosphorus plant uptake. 2. Irrigation management to keep the average soil moisture to increase solubility and phosphorus uptake and finally, regeneration and implementation of artificial macronutrients to provide preferential flow in soil (in order to induce favorable conditions for phosphorus bioavailability). The results showed that because of the high natural alkalinity of the soil, the proportion of Clinoptilolite used, was inadequate (at a level of 2% weight of soil, phosphorus uptake was not significantly increased (at the level of 5%)). The amount of Clinoptilolite used, were based on the economic justification of large-scale implementation of the project. However, a higher amounts of Zeolite, is expected to increase the uptake of phosphates. Fertilizability of high proportions of Zeolite in large scales needs to be further investigated. Furthermore, time management of irrigation in order to maintain a higher average soil moisture as well as reproduction of artificial macronutrients, despite their theoretical justifications to increase plant uptake of phosphates was insufficient. These results can also be attributed to soil characteristics to prepare the pots, and as a result, a different action of soil structure in addition to other conditions such as high crop density per area, which resulted in higher rate of water consumption which prevented deep percolation loss.

6. REFERENCES