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| Title: | Porous Particles for plant agronutrient delivery |
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| Abstract: | Nutrients are the elements required by plants for the growth and reproduction, hence their deficiencies can severely affect the plant growth and yield. These nutrient requirements are met by supplementing the soil with fertilizers. However, these conventional fertilizers are susceptible to several issues like surface run off, leaching and environmental degradation etc. To overcome these problems, we have developed 3 approaches for a targeted, controlled and sustainable release. In the first study mesoporous silica particles were prepared as carriers and used for the application of a micronutrient viz., iron. The prepared carrier loaded with the nutrient was coated with a cationic biopolymer viz., chitosan to serve dual function in the developed targeted nutrient application system. 1. Chitosan acted as barrier to prevent the conversion of iron into its biologically unavailable forms by the carbonate and bicarbonates present in the soil, 2. acted as a interactive medium between mesoporous silica particles and plant roots to release the nutrient in targeted fashion. The coated particles showed a controlled and targeted release, and the findings were validated on tomato plant where the ferric chelate reductase activity (FCR). The FCR expression by the plant treated with the composite showed significantly reduction (by ~20%) compared to the uncoated and free form of fertilizer. In the second study we explored another type of porous particles in the form of metal organic frameworks (MOF) based on their chemical and physical properties like high surface area. The MOF were used as the carrier for the application of a macronutrient nitrogen in the form of urea. The ease of post synthesis modification in MOF allowed to coat biopolymer chitosan as used in our previous study. The coated particles showed a high loading capacity of 94% and sustained release pattern up to 48 hrs. The applicability of developed particle was validated in tomato plant, where the application of 6 mg of particle for 200 ml of hydroponic medium was able to meet the nitrogen requirement for the plants. In the third study we used low, dense cellulose with huge loading capacity as the fertilizer reservoir. However, the pore retention property of cellulose alone is quite poor for multiple cycles. To overcome this, a stable cellulose aerogel has been prepared by grafting porous silica on the surface. The aerogel prepared shows significantly more absorption capacity in the 5th cycle than the fiber alone. Further this aerogel was used for urea loading and the release kinetics, which showed lower urea release kinetics than naked porous silica and cellulose, in acidic condition, which qualifies it to be a sustainable fertilizer reservoir in acidic soil. |
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