EDITORIAL

Nanobotany: An Important Line of Research for Botanists

COLUMN

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Nanotechnology has opened many new avenues for the researchers in various fields of science and technology. In biological sciences, it has widened scope for scientists and researchers and a number of applications have been invented. Significant research advances have been undertaken on the use of nanoparticles in various disciplines of botany. Nanoparticles are used to study the physiology of plants and several industrial uses.

Enormous energy efficiency by virtue of tiny size and enormous surface area per unit mass, enables nanoparticles to transform and revolutionize various fields of technology including aerospace, aviation, homeland security, national defense, energy, environmental improvement, information technology, medicine, transportation, biotechnology, agriculture etc. The commonly used nanoparticles are $nSiO_2$, $nTiO_2$, $nZnO_2$, CuO_2 An array of approaches for the biological synthesis of nanoparticles using plant extract has been used to decrease metal ions to nanoparticles in a single-step green synthesis process. The reducing agents involved include the various water soluble plant metabolites (e.g. alkaloids, phenolic compounds, terpenoids) and co-enzymes. Plant based synthesis of silver (Ag) and gold (Au) nanoparticles have been developed. Extracts of a diverse range of plant species have been successfully applied in making nanoparticles. In addition to plant extracts, live plants can be used for the synthesis of nanoparticles. Commercially, available plant powders such as *Solanum tricobatum, Syzygium cumini, Centella asiatica* and *Citrus sinensis* offers an eco-friendly synthesis of silver nanoparticles from a silver nitrate solution. Similarly, bio-fabrication of zinc oxide nanoparticles can be done using leaf extract of *Parthenium hysterophorus* L. In agriculture, nanoparticles have potential applications in all fields like gene transfer, seed germination and vigour, input use efficiency by using nano-fertilizers and nano-pesticides, longevity of shelf life in perishable horticultural products, storage, nano-based treatment of agricultural waste, nanosensors based agriculture.

The application of $nSiO_2$, $nTiO_2$, $nZnO_2$, CuO_2 significantly improved seed germination and vigour and subsequently the growth and yield of crop. Encapsulation of nutrients, growth regulators and pesticides at nanoscale enhances the efficiency by targeted and slow release. The targeted delivery of nanaparticle based agricultural inputs can lower down dosages. In certain cases, nanoparticles themselves also act as growth regulators. Application of nanosilver by pulse method to cut flowers enhanced vase life, water uptake rate, and fresh weight and reduced the number of bacteria, water loss, stomatal conductance and transpiration rate.

The nanotechnology has shown remarkable effects on the plant lifecycle. The researchers across the globe are working on various aspects of the technology in relation to plant. However, the information so generated is scattered and there is lack of a concrete nanobotanical approaches or methods that can be employed for the better utilization of plants for mankind. However, at the same time, synthetic nanomaterials may possibly contaminate the ecosytem. Current understanding

of its fate and adverse effects in agricultural systems is poor. Agricultural crops grown using Nm-containing pesticide and fertilizer formulations or spills, or Nm-containing biosolids may pose a substantial negative impact. Overall, nanotechnology may emerge as revolutionary mechanism overcoming its limitation in modern agriculture.