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Science news

Carbon nanotubes for green deserts

Thanks to their novel physical and chemical properties, carbon nanotubes or CNTs — the cylindrical carbon molecules — have become potentially useful in a number of applications.

Now scientists at the Indian Institute of Technology in Kanpur (IITK) have reported[1] a finding that can open up prospects of their use in agriculture in arid regions.

They have, for the first time, shown that water soluble CNTs(wsCNTs) can accelerate the growth rate of plants by dramatically enhancing their water uptake. They have experimentally demonstrated this remarkable effect of these nanotubes in the case of *Cicer arietinum* seed, also known as Bengal gram.

It is already known that single or multiwalled CNTs, due to their tubular structure, can penetrate membranes of plant cells. However, these CNTs are toxic to plant cells and could damage their biological barriers (cell membranes).

Sabyasachi Sarkar and coworkers in the IITK chemistry department avoided this problem by using a water soluble form of CNT (wsCNT) which they produced by a simple method[2].

Sabyasachi Sarkar.

They attached certain molecules to the CNTs to improve their 'hydrophilic' property so that they could be solubilized in water. "Unlike CNTs, we found that the water soluble nanotubes are non-toxic to plant cells," Sarkar told *Nature India*. The team has shown that these wsCNTs actually stimulate the growth of Bengal gram plant by increasing the water uptake by the roots.

The researchers monitored the growth of one-day-old sprouted gram seeds after treating them with different concentrations of wsCNT. For comparison, another set of seeds (control group) were grown in distilled water without wsCNT. The root length, shoot length, number of roots and water uptake by gram plants in the treated and control groups were monitored for 10 days and compared. They report that the growth rate of the plants in the presence of wsCNTs increased several times as compared to control plants.

The enhanced water uptake was the result of wsCNTs aligning head to tail forming several new capillaries within the plant's xylem, the pipeline that carries water and nutrients from the roots to the leaves. Furthermore, the narrow space between wsCNTs provides additional channels which increase the water uptake mechanism of the plant in addition to their natural flow. Sarkar says scanning electron microscope images clearly show the formation of new capillaries in roots treated with wsCNT but not in blank roots. "For the induced growth mechanism, it might be possible that wsCNT, after attaching to the root surface or an inner portion of root (such as vascular bundles, cortical region etc.), aligned itself to enhance the capillary action of water absorption," the scientists report.

"In summary, our work describes a simple and rapid method for the application of wsCNTs in the field of agriculture and to investigate the interactions of wsCNTs with plant cells," the scientists conclude. "We provide evidence by optical, fluorescence, scanning and transmission electron microscopy that these wsCNTs are taken up by plants. Finally, we demonstrate that the continuous use of wsCNTs is non-toxic to plants."

A key implication of this work, according to the Kanpur researchers, is that the use of wsCNTs in plant growth "can play an important role in the arid areas of agriculture where the supply of water is crucial and

requires maximum conservation."

The researchers said their future research would aim to determine the actual mechanism for the alignment of wsCNTs across the xylem and focus on understanding the influence of these carbon nanotubes in different stages like flowering and fruit ripening.

References

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2. Dubey, P. *et al.* Synthesis and characterization of water-soluble carbon nanotubes from mustard soot. *Pramana* **65**, 681-697 (2005) | **Article** | **ISI** | **ADS** | **ChemPort** |

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