**UPTAKE, TRANSPORT AND TRANSLOCATION:**

Several studies have shown that carbon-based nanomaterials, such as carbon quantum dots (CQDs), carbon nanotubes (CNTs), and fullerenes, can be taken up by plants and transported through the vascular system. The unique fluorescence signal of CQDs makes them particularly suitable for tracking purposes in plants. To investigate the uptake, translocation, and accumulation of CQDs, (Li et al., 2020) used mung bean as a model plant. The researchers observed the germination and growth of the seedlings after five days of incubation and used confocal laser scanning microscopy (CLSM) and transmission electron microscopy (TEM) to locate the CQDs in different parts of the seedlings. They found that CQDs entered the seed coating through the intercellular space and accumulated in the cotyledons to speed up seed germination. Later, CQDs were adsorbed on the root surface and penetrated the root vascular bundles before being transferred to the veins of the leaves through the vascular system.

In a similar study, (Lin et al., 2009) used rice plants to demonstrate the generational uptake, translocation, and transmission of carbon nanomaterials. They primed newly harvested rice seeds in a petri dish with C70–NOM and MWNT–Natural organic matter and grew the seedlings to maturity in a greenhouse. The researchers found that nanomaterials were frequently found in seeds and roots and less frequently in stems and leaves. They observed black aggregates near the vascular system of the stems, indicating their simultaneous transport with the uptake of water and nutrients. Later, dots were spotted in the form of aggregates in the veins of leaves, indicating their accumulation.

(Chen et al., 2010) used Allium cepa to exemplify the uptake of carbon nanomaterials. They incubated plant cells with fullerene C-70 suspended in natural organic matter and fullerol C-60(OH)20, a water-soluble fullerene derivative, at different doses. The researchers found that C-70 aggregates were mostly adsorbed on or trapped within the hydrophobic cellulose matrices of the plant cell walls, suggesting an apoplastic pathway of uptake and translocation.

(Gong & Dong, 2021) used wheat as a model plant to explain the transfer, transportation, and accumulation of Cerium-doped CQDs. They found that CDs:Ce were absorbed by root hairs of wheat and then transported through the vascular system of stems and leaves via fibrovascular tissues. The researchers observed that the root system is the primary site of biological accumulation of CDs:Ce, but most of the accumulation was observed in the veins and stomata of the leaves.

Overall, these studies provide insights into the mechanisms underlying the uptake, translocation, and accumulation of carbon-based nanomaterials in plants. The unique fluorescence signal of CQDs offers a promising method for tracking them in plants, and further research in this area may lead to the development of novel applications of carbon-based nanomaterials in agriculture and biotechnology.