Urea functionalized multiwalled carbon nanotubes as efficient nitrogen delivery system for rice

By: Yatim, NM (Yatim, Norazlina Mohamad)[1]; Shaaban, A (Shaaban, Azizah)[1]; Dimin, MF (Dimin, Mohd Fairuz)[1]; Mohamad, N (Mohamad, Noraiham)[1]; Yusof, F (Yusof, Faridah)[2]

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Abstract

This paper utilized urea functionalized multiwalled carbon nanotubes fertilizer as plant nutrition for rice to understand fully their mechanism of interaction. Surface modification of multiwalled carbon nanotubes was treated by nitric acid at different reflux times. The individual and interaction effects between the design factors of functionalized multiwalled carbon nanotube amount and functionalization reflux time with the corresponding responses of nitrogen uptake and nitrogen use efficiency were structured via the Response Surface Methodology based on five-level central composite design. The urea functionalized multiwalled carbon nanotubes fertilizer with optimized 0.5 weight% functionalized multiwalled carbon nanotubes treated at 21 h of reflux time achieve tremendous nitrogen uptake at 1180 mg/pot and NUE up to 96%. The FT-IR results confirm the formation of acidic functional groups of functionalized MWCNTs and UF-MWCNTs. The morphological observation of transmission electron microscopy shows extracellular regions to be the preferred localization of functionalized multiwalled carbon nanotubes in fresh plant root cells independent of their size and geometry. Penetration into the plant cell results in breaching of graphitic tubular structure of functionalized multiwalled carbon nanotubes with their length being shortened until similar to 50 nm and diameters becoming thinner until less than 10 nm. The capability to agglomerate after translocation into the plant cells alarms potential cytotoxicity effect of functionalized multiwalled carbon nanotubes in agriculture. These work findings have suggested using urea functionalized multiwalled carbon nanotubes for effective nutrient delivery systems in rice plant.

Keywords

Author Keywords: functionalized-MWCNTs; grafted; urea; plant cell; cytotoxicity
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Author Information

Reprint Address: Yatim, NM (reprint author)

Univ Tekn Malaysia Melaka, Adv Mfg Ctr, Fak Kejuruteraan Pembuatan, Durian Tunggal 76100, Melaka, Malaysia.

Addresses:

[1] Univ Tekn Malaysia Melaka, Adv Mfg Ctr, Fak Kejuruteraan Pembuatan, Durian Tunggal 76100, Melaka, Malaysia

[2] Int Islamic Univ Malaysia, Dept Biotechnol Engn, Kulliyah Engn, POB 10, Kuala Lumpur 50728, Malaysia

E-mail Addresses: norazlina.yatim@utem.edu.my

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Cited References: 50

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1. **Length-dependent uptake of DNA-wrapped single-walled carbon nanotubes** — Times Cited: 137
   By: Becker, Matthew L.; Fagan, Jeffrey A.; Gallant, Nathan D.; et al.
   ADVANCED MATERIALS Volume: 19 Issue: 7 Pages: 939-+ Published: APR 6 2007

2. **Nanosilver: US EPA's pesticide office considers how best to proceed** — Times Cited: 23
   By: Bergeson, LL.
   Environ Qual Manage Volume: 19 Issue: 3 Pages: 79-85 Published: 2010

3. **Biomedical applications of functionalised carbon nanotubes** — Times Cited: 802
   By: Bianco, A; Kostarelos, K; Partidos, CD; et al.
   CHEMICAL COMMUNICATIONS Issue: 5 Pages: 571-577 Published: 2005

4. **Nitrogen-15 balance as affected by rice straw management in a rice-wheat rotation in northwest India** — Times Cited: 28
   By: Bijay-Singh; Bronson, KF; Yadvinder-Singh; et al.
   NUTRIENT CYCLING IN AGROECOSYSTEMS Volume: 59 Issue: 3 Pages: 227-237 Published: 2001

5. **Traditional and Modern Plant Breeding Methods with Examples in Rice (Oryza sativa L.)** — Times Cited: 40
   By: Breseghello, Flavio; Guedes Coelho, Alexandre Siqueira
   JOURNAL OF AGRICULTURAL AND FOOD CHEMISTRY Volume: 61 Issue: 35 Pages: 8277-8286 Published: SEP 4 2013

6. **Nanotechnology: The new perspective in precision agriculture.** — Times Cited: 90
   By: Duhan, Joginder Singh; Kumar, Ravinder; Kumar, Naresh; et al.
   Biotechnology reports (Amsterdam, Netherlands) Volume: 15 Pages: 11-23 Published: 2017-Sep

7. **The evaluation of toxicity of carbon nanotubes on the human adipose-derived-stem cells in-vitro.** — Times Cited: 11
   By: Esfandiary, E; Valiani, A; Hashemibeni, B; et al.
   Advanced biomedical research Volume: 3 Pages: 40 Published: 2014

8. **Polyurea-functionalized multiwalled carbon nanotubes: Synthesis, morphology, and Raman spectroscopy** — Times Cited: 199
   By: Gao, C; Jin, YZ; Kong, H; et al.
   JOURNAL OF PHYSICAL CHEMISTRY B Volume: 109 Issue: 24 Pages: 11925-11932 Published: JUN 23 2005

9. **Mechanism of nano-anatase TiO2 on promoting photosynthetic carbon reaction of spinach - Inducing complex of Rubisco-Rubisco activase** — Times Cited: 102
   By: Gao, Fengqing; Hong, Fashui; Liu, Chao; et al.
   BIOLOGICAL TRACE ELEMENT RESEARCH Volume: 111 Issue: 1-3 Pages: 239-253 Published: SUM 2006

10. **Phytotoxicity of Carbon Nanotubes Assessed by Brassica Juncea and Phaseolus Mungo** — Times Cited: 30
    By: Ghodake, Gajanan; Seo, Yeong Deuk; Park, Donghee; et al.
    JOURNAL OF NANOELECTRONICS AND OPTOELECTRONICS Volume: 5 Issue: 2 Special Issue: SI Pages: 157-160 Published: AUG 2010

11. **In situ synthesis of green bionanocomposites based on aqueous citric acid cured epoxidized soybean oil-carboxylic acid functionalized multiwalled carbon nanotubes** — Times Cited: 11
    By: Gogoi, Pronob; Horo, Himali; Khannam, Momina; et al.
    INDUSTRIAL CROPS AND PRODUCTS Volume: 76 Pages: 346-354 Published: DEC 15 2015