

Plant Nutrient Nanoparticles Encapsulated Cellulose Matrix for Slow and Sustained Release of Nitrogen

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Are We Ready to Feed the 7 Billion World Population?



Scientific American, Nov. 2011

One billion people suffer from chronic hunger

> 6000 patents in USPTO

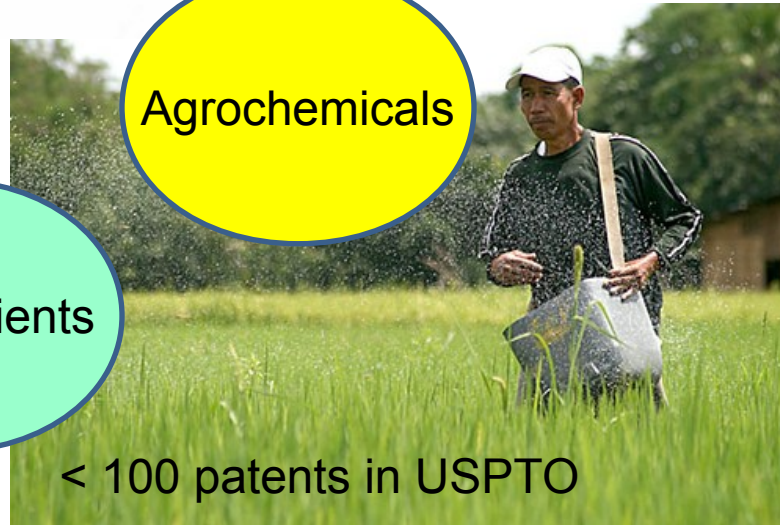
Health
is
Wealth

Food plays a major role for good health

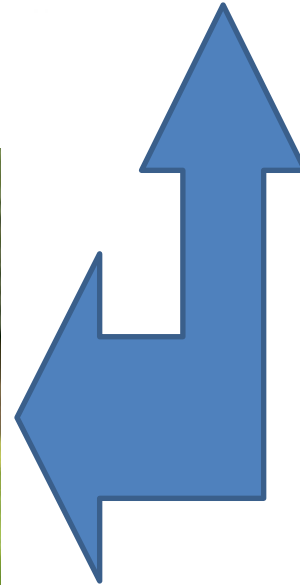


Agrochemicals

Plant nutrients



< 100 patents in USPTO



Good fertilization practices are the key to quality crop yields



Current Issues with Fertilization



Rock phosphate



Potash



Low solubility and complexation leads to lower absorption by plants.

High solubility and unavailability for plants

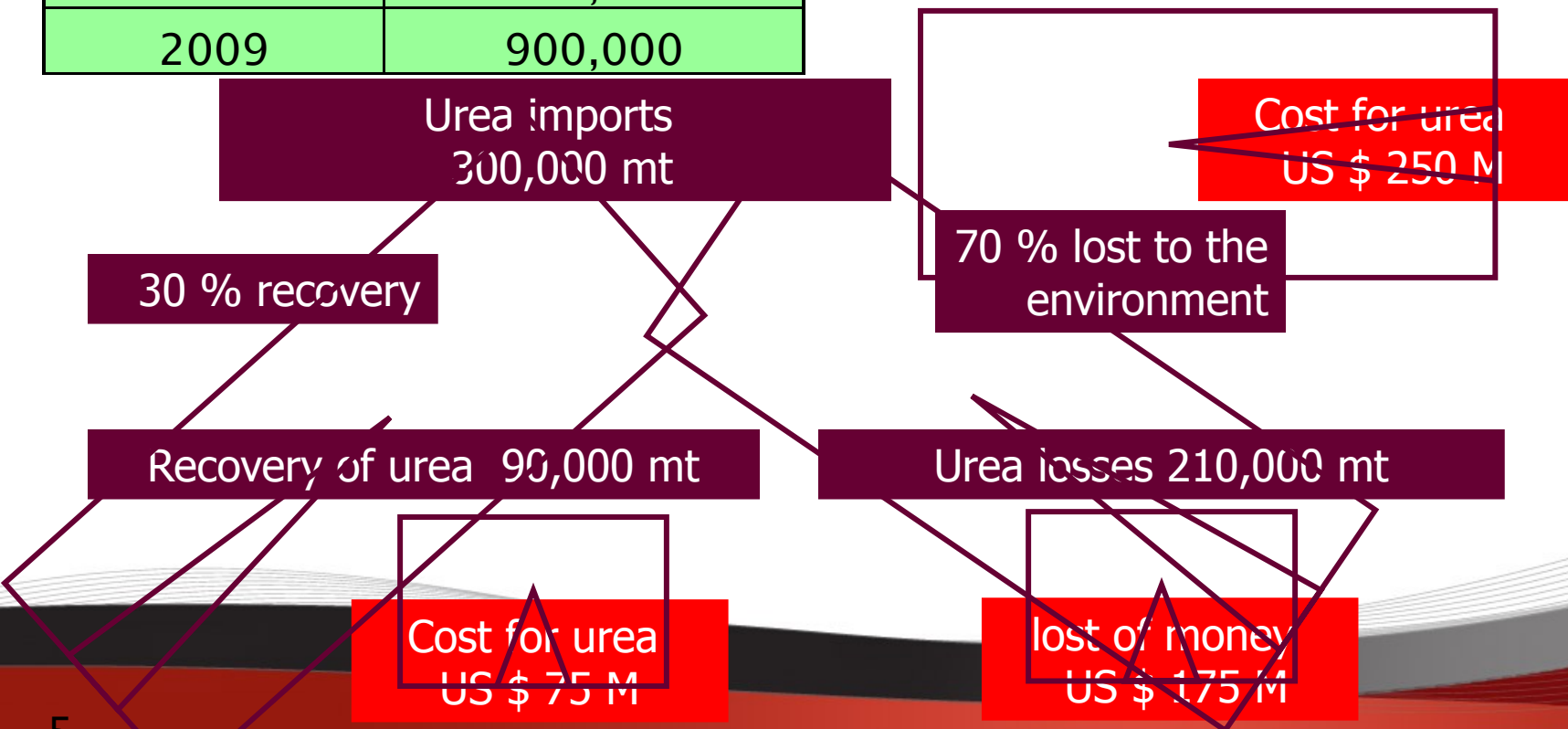
50 – 70 % wasted as emissions and as water soluble compounds, leading to lower efficiency and several environmental issues

Fertilizer Usage (2005–2009)



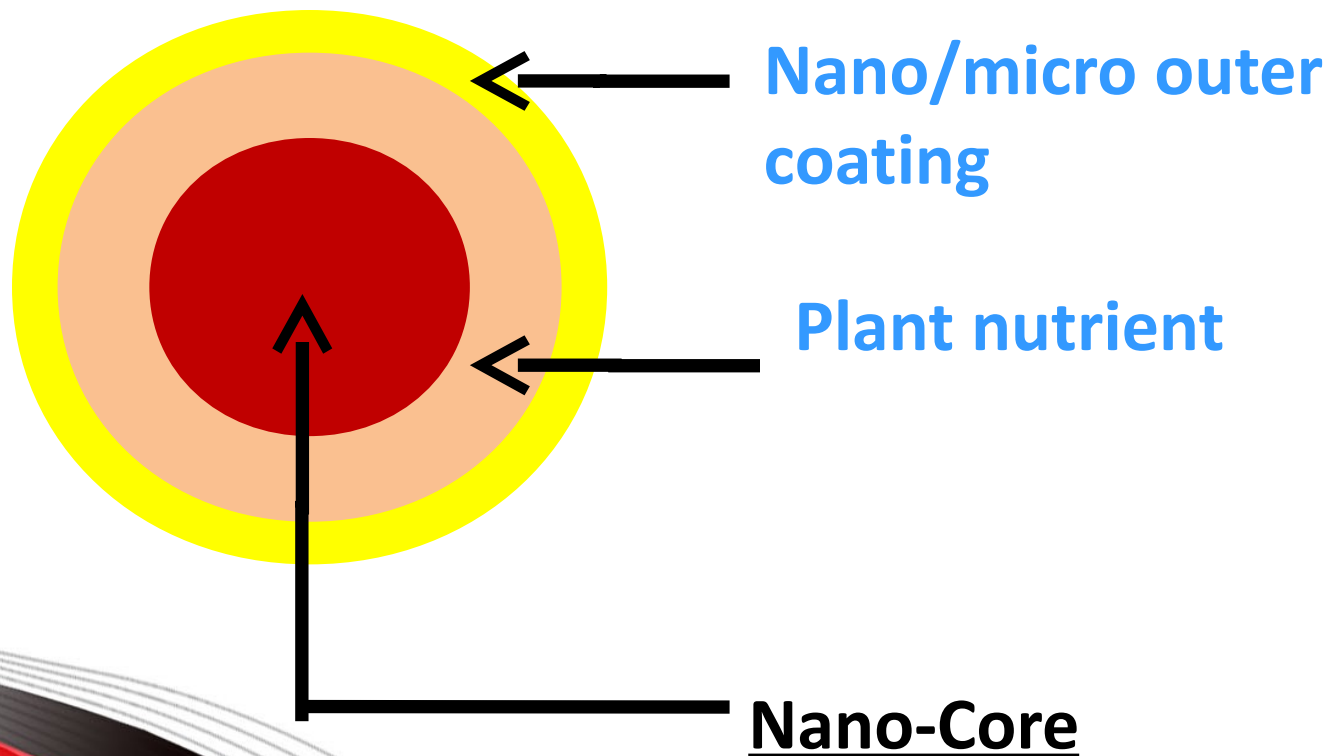
Year	Total Fertilizer Qty(Mt)
2005	652,262
2006	713,600
2007	666,349
2008	743,646
2009	900,000

Saving of 10 % urea estimated to save US \$ 25 M, while minimizing the affects to the environment.

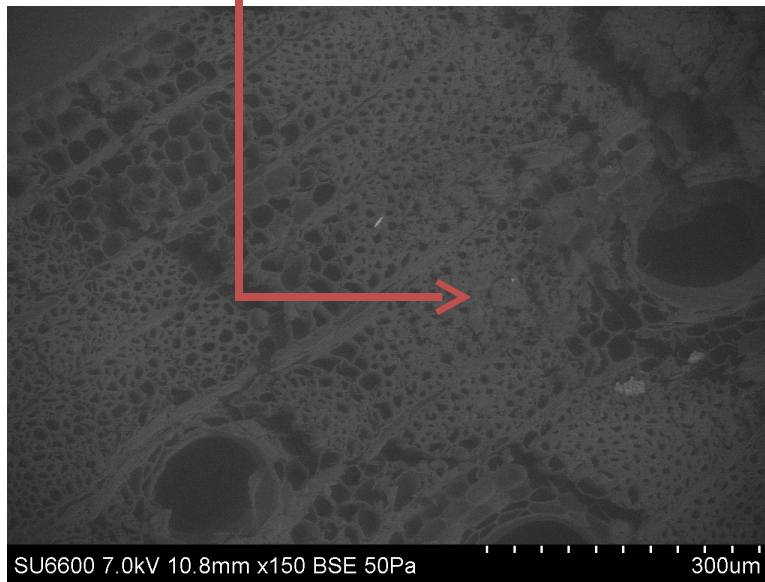
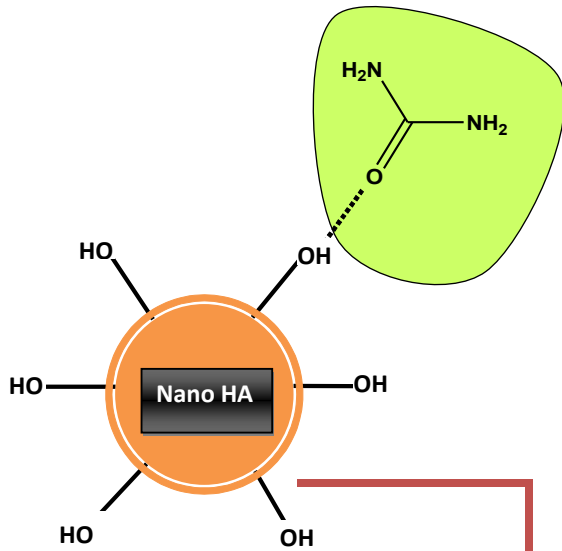


Need an Efficient Fertilization Mechanism

- Slow release fertilizer/agrochemicals based on Nanotechnology



Slow Release Fertilizer



- Pressurize into the nano/micro cell cavities of *Glicidia sepium*

Encapsulation of urea modified nano HA into Gliricidia stem

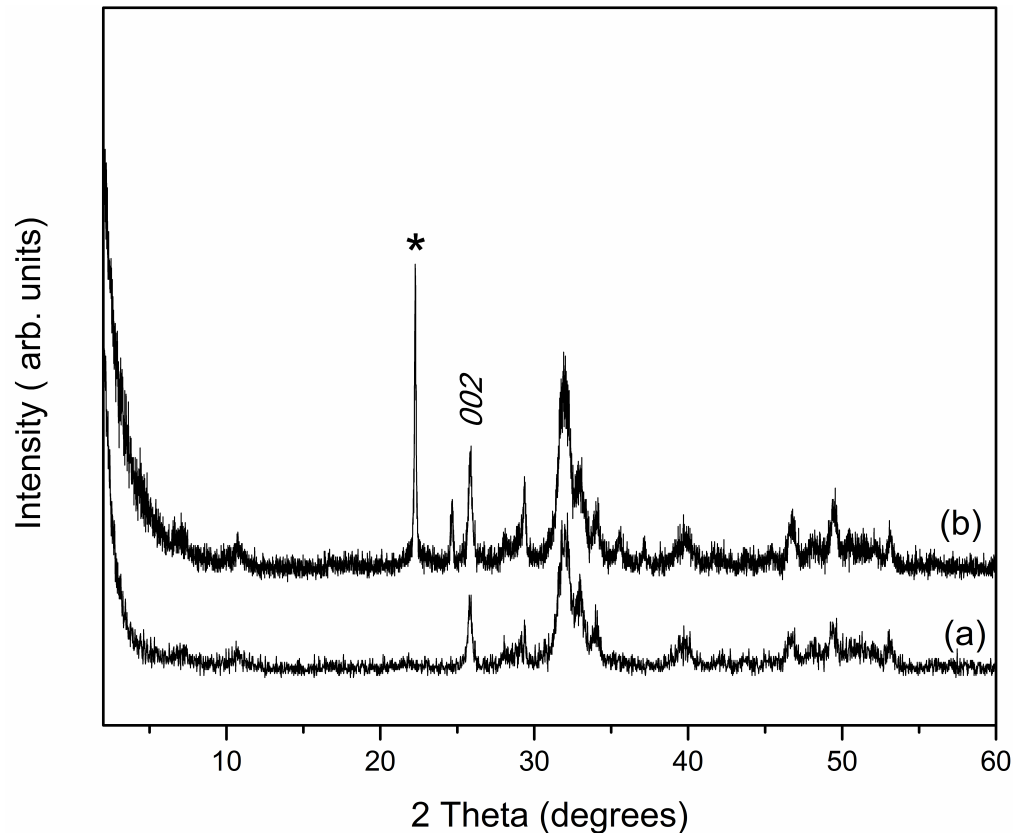


Photo - Chris Gardiner ©

SUNTEC
Sustainable nanotechnology

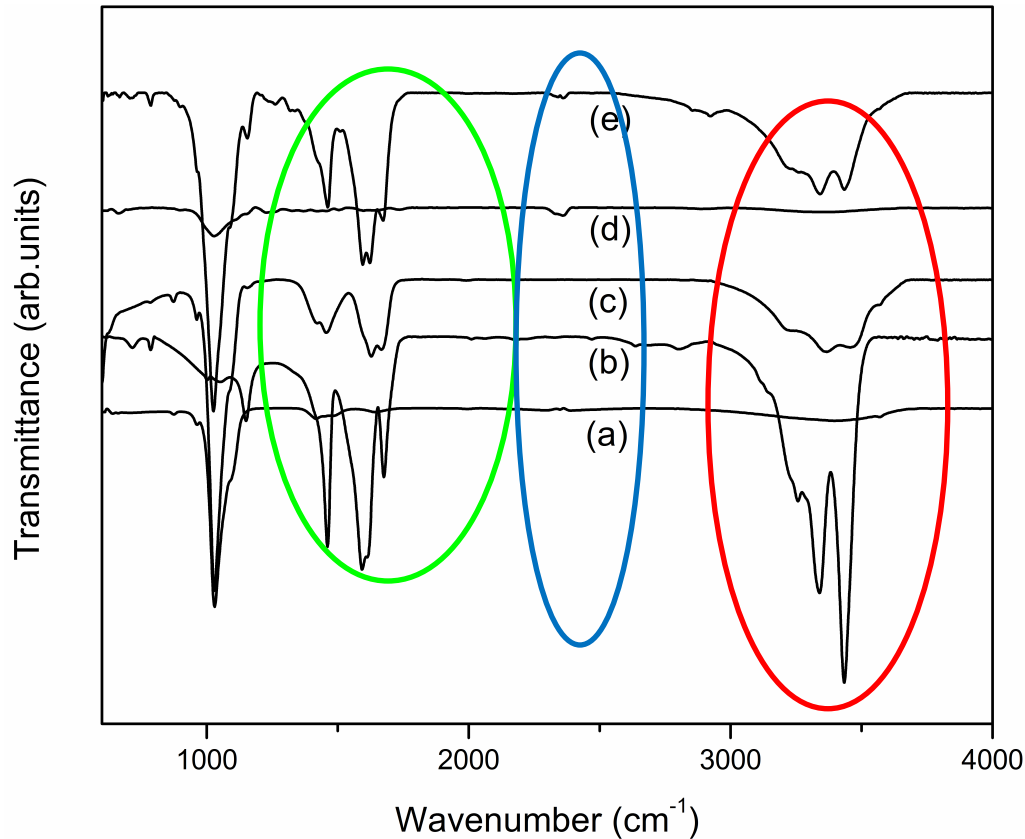


PXRD Characterization



PXRD pattern of (a) synthesized HA nanoparticles (b) urea surface modified HA nanoparticles. (* denotes the diffraction peak due to urea)

FTIR Characterization

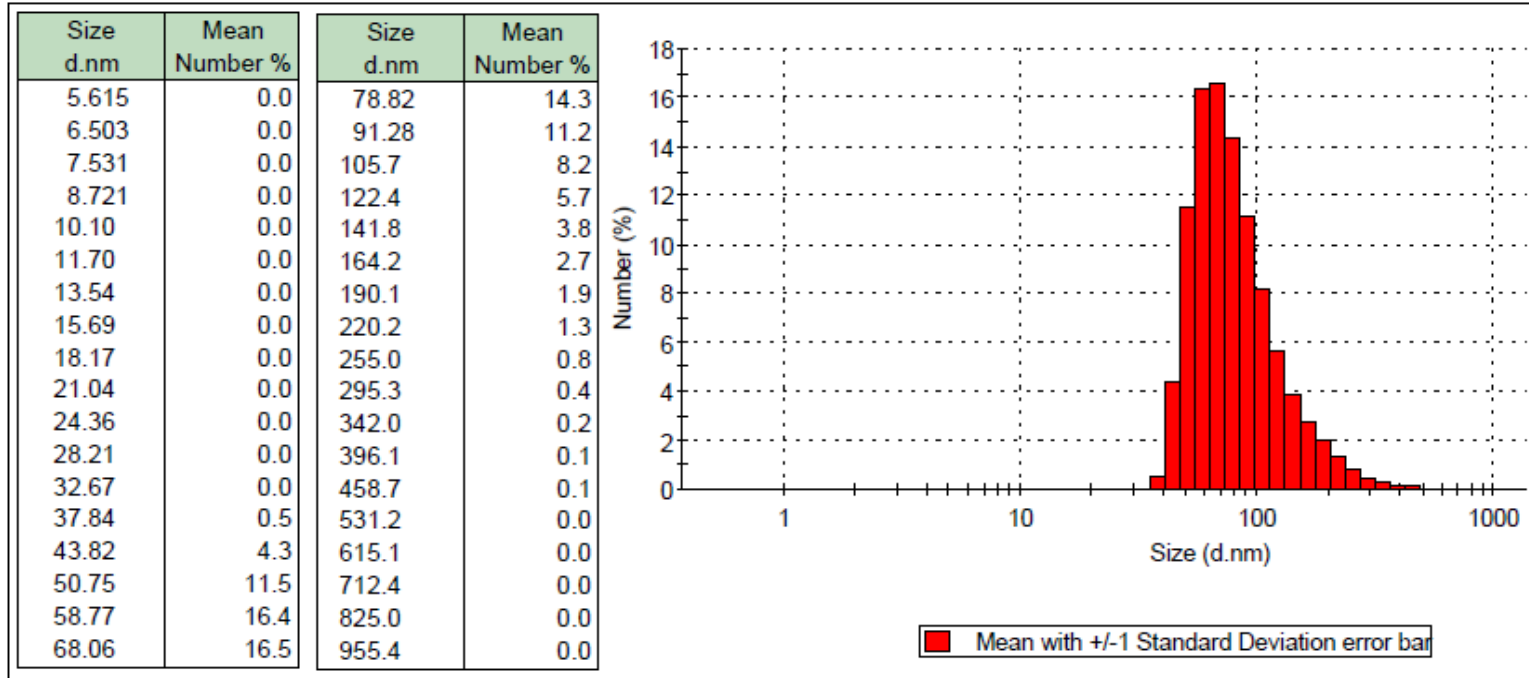


- (a) synthesized HA nanoparticles
- (b) Urea
- (c) Urea modified HA nanoparticles
- (d) Untreated *G. sepium*
- (e) Urea modified HA nanoparticles encapsulated *G. sepium*.

Successful surface modification of HA nanoparticles are suggested by the wavenumber shift and the broadness of the peak intensities corresponding to

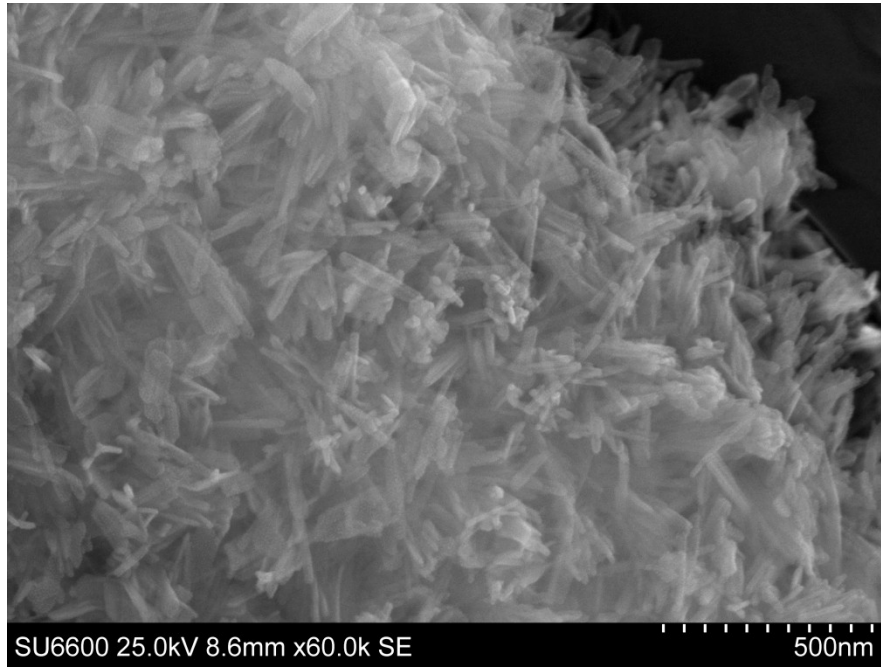
1. Carbonyl and amine stretching frequencies of urea
2. Hydroxy and phosphate stretching frequency of HA nanoparticles

Particle Size Analysis

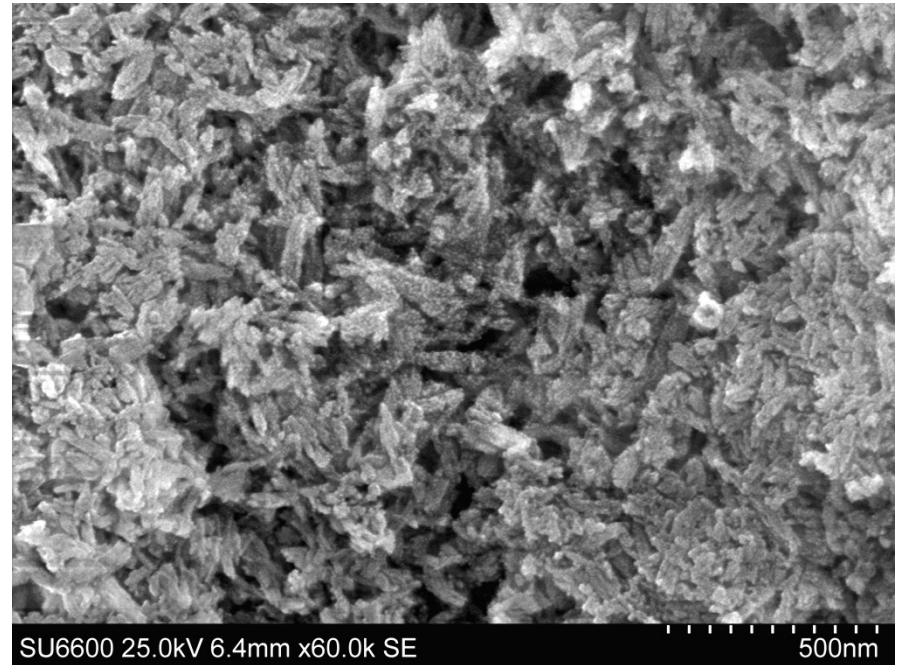


More than 80% of the particles < 100 nm

SEM Images



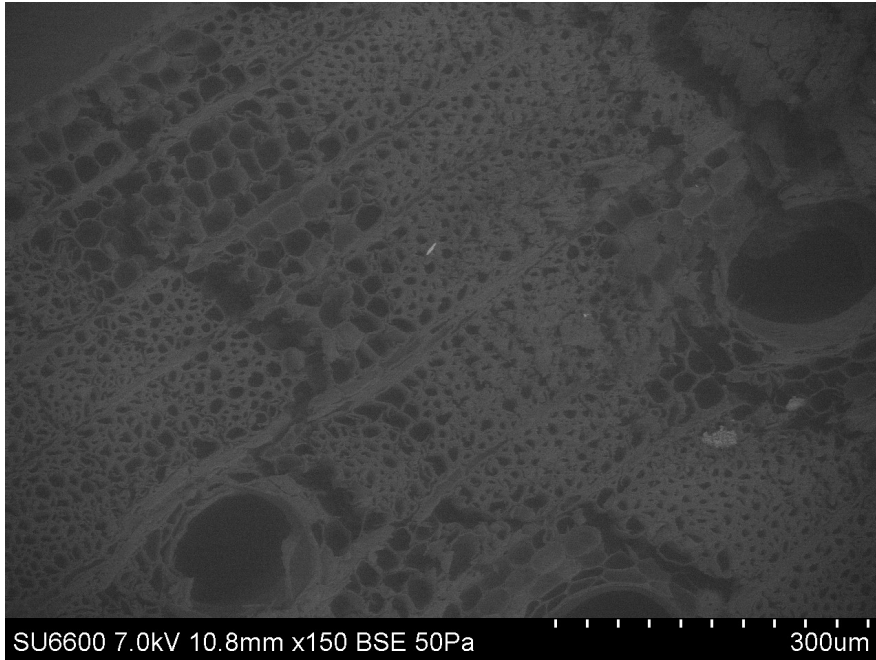
(a)



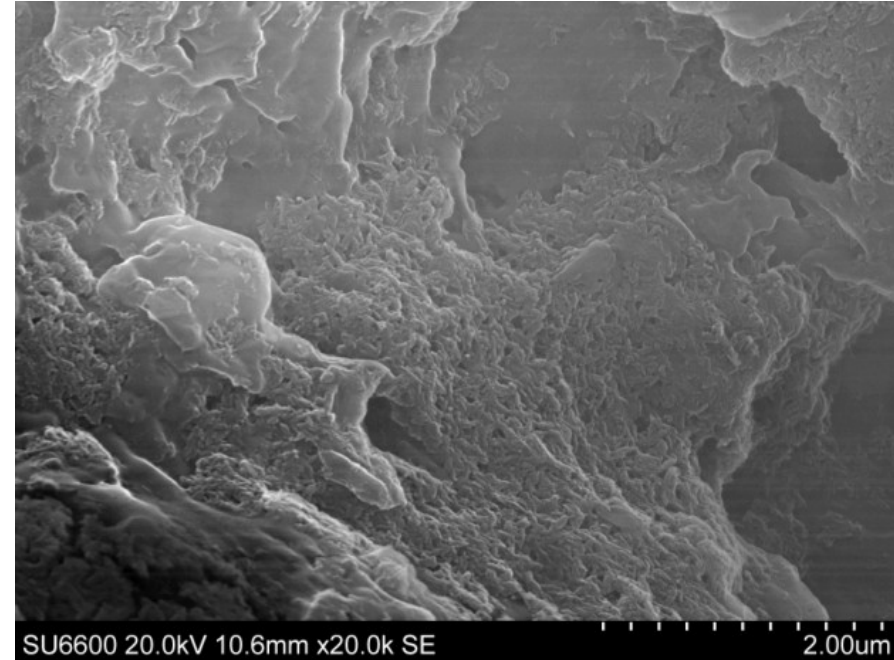
(b)

SEM images of (a) synthesized HA nanoparticles
(b) urea modified HA nanoparticles.

SEM Images (Contd.)



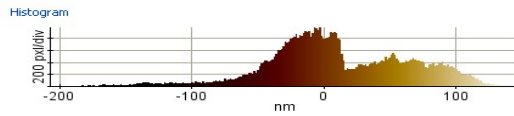
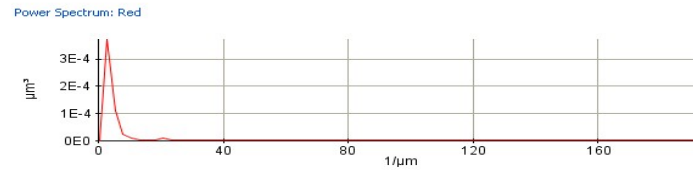
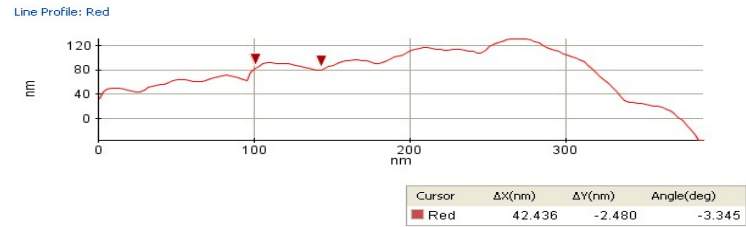
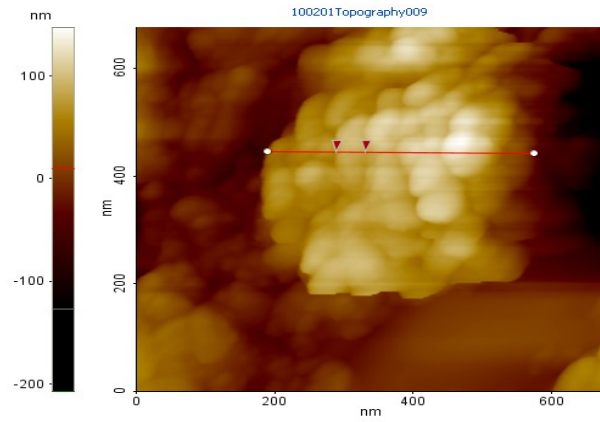
Gliricedia sepium stem



SEM images of Urea modified nano HA impregnated *Gliricedia sepium*.

Elemental analysis
N 16% P 4% Ca 8%

Topographic image of nano HA



Line	Min(nm)	Max(nm)	Mid(nm)	Mean(nm)	Rpv(nm)	Rq(nm)	Ra(nm)	Rz(nm)	Rsk	Rku
Red	-35.842	131.288	47.723	76.879	167.130	36.358	29.855	42.739	0.726	3.096

Proof of Concept

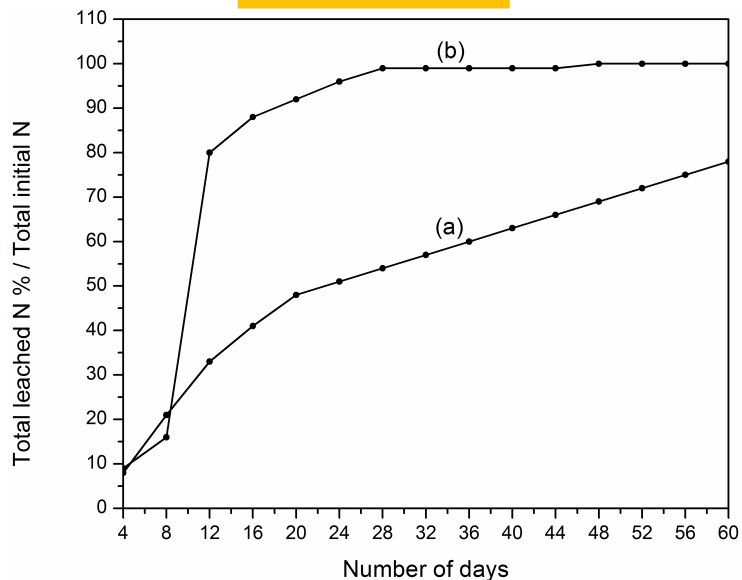


Release behavior of the fertilizer system was studied in

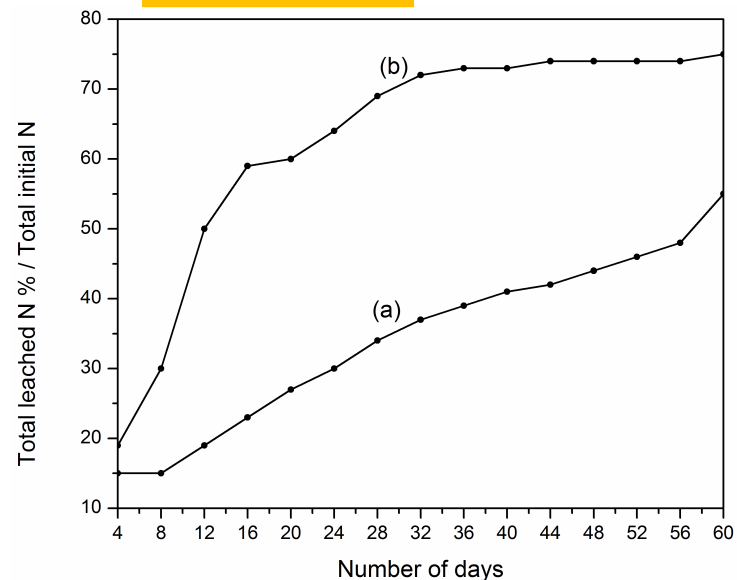
1. Up country tea soil – 5400 ft elevation (pH 4.2)
2. Mid country tea soil – 1600 ft elevation (pH 5.2)
3. Sandy soil – sea level (pH 7)

Release Behavior Studies in Soil

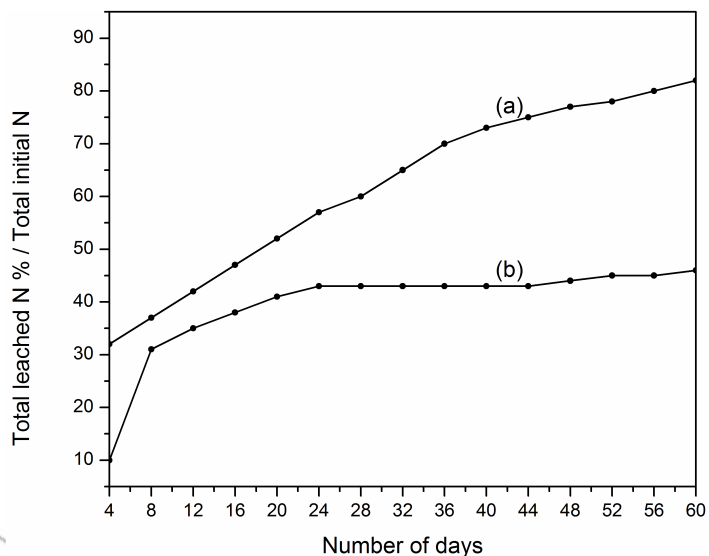
pH 4.2 Soil



pH 5.2 Soil



pH 7.0 Soil



(a) Nanofertilizer

(b) Commercial fertilizer

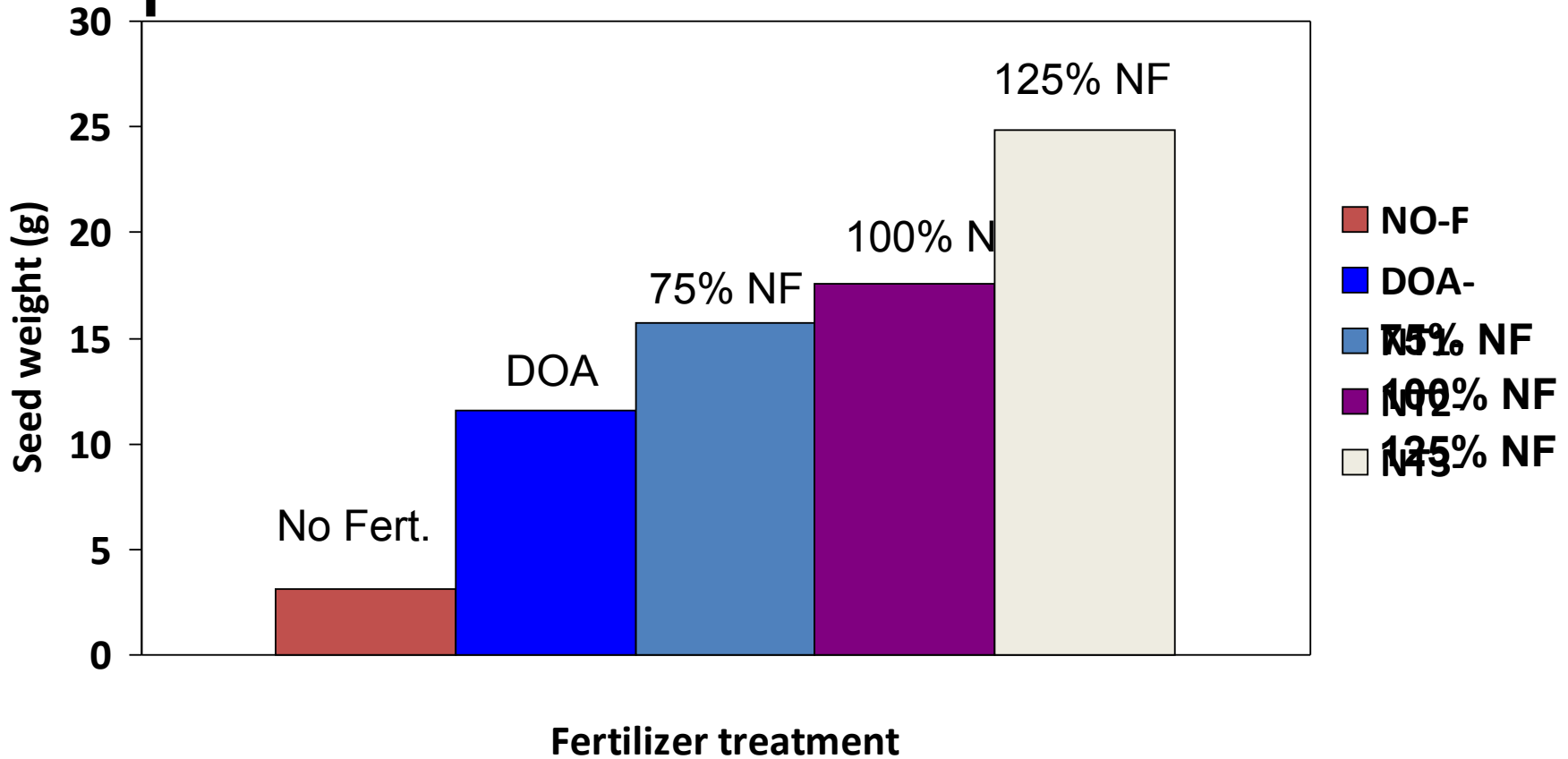
Field Studies



- Urea based fertilizer- after 6 months

- Nano fertilizer -after 6 months

Total seed weight (g/pot) – Respond to N



Acknowledgements

- Hayleys Agro Ltd.
- Tea Research Institute of Sri Lanka.

Thank you