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SYNTHESIS OF A HYBRID NANOFERTILIZER BASED ON NANO UREA

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Abstract: **In order to bridge the gap between supply and demands of the latest nanotechnology advances for agriculture and to develop the agricultural productivity and cultivation. Formulation of Hybrid Nano Fertilizer (HNF) based on Nano Urea. In this Urea-Modified Hydroxyapatite was synthesized, which is a rich source of nitrogen, calcium, and phosphate. Nanoparticles such as copper, iron, and zinc were incorporated into urea-modified hydroxyapatite to increase the efficiency of the proposed fertilizer. Different techniques including X-ray powder diffraction, Raman spectroscopy, and Scanning electron microscopy were used to get insight into the properties, morphology, and structure of the as prepared fertilizer. The developed HNF was used in a field experiment on the ladies' finger (abelmoschus esculentus) plant.**

Furthermore, the presence of the nutrients in ladies' finger was confirmed by observing the plant growth, leaf size, height, and the total number of leaves in a stem. The composition of the proposed HNF was functionally valuable for slow and sustainable release of plant nutrients. The dose of prepared HNF applied was 50mg/week, varying the water supply to the abelmoschus esculents. The obtained results showed a significant increase of cu2+, fe2+, and zn2+ nutrient uptake in abelmoschus esculents as a result of slow release from HNF

Keywords: **Hybrid Nano Fertilizer, Nano urea, Urea-Modified Hydroxyapatite, X-Ray Diffraction, Raman Spectroscopy, Scanning Electron Microscope.**

I. INTRODUCTION:

A fertilizer could be a source of soil supplements, which upgrades the plant development and increments the efficiency. Ranchers have been utilizing commercial fertilizers broadly for the final 50 a long time, which contain a adjusted dispersion of the three fundamental basic supplements required for optimum plant development: nitrogen, phosphorous, and potassium. The foremost commonly utilized commercial fertilizers are single superphosphate (SSP), triple superphosphate (TSP), urea, nitrogen–phosphorous–potassium (NPK), monoammonium phosphate (Outline), and diammonium phosphate (DAP), which supply the fundamental plant supplements such as nitrogen, potassium, and phosphorus. The application of these fertilizers results in gigantic financial misfortunes due to 40–70% of leaching-related issues, which cause sensational misfortunes within the soil nutrients and diminish the ripeness of the soil. Moreover, the utilize of large-scale commercial fertilizers for a long period isn't a fitting handle to upgrade the trim efficiency since it causes exceptional harm to the soil microbial greenery, soil structure, plants, and indeed to the environment. Abundance utilize of fertilizers causes natural contamination as their leftover and unused sums ended up poisons for discuss, water, and soil. On the other hand, the application of fertilizers that appear moderate and economical discharge of supplements is thought to move forward supplement utilization as detailed within the literature. In this manner, detailing of a unused fertilizer is required to discharge supplements gradually and reasonably so that the soil and plants can take up supplements easily. Nanotechnology could be a methodology with gigantic potential to fathom these agriculture-related issues like decrease in arrive quality, moo trim efficiency, supplement lack, filtering misfortunes, etc. It has been detailed that the nanostructure of nano fertilizers gives a tall surface area-to-volume proportion that empowers plants to require up supplements gradually and reasonably as required. Other than, nano fertilizers have numerous benefits such as progressing soil ripeness, lessening supplement misfortune, expanding edit yield, lowering natural contamination, and giving a attainable environment for microorganisms. Numerous

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analysts have defined slow-release fertilizers by joining hydroxyapatite (HA) and urea to extend conveyance of supplements to the plants. In this foundation, we report here a cross breed nano fertilizer (HNF) composition with a few expansions, which is made by consolidating nano urea-modified hydroxyapatite nanoparticles into copper, iron, and zinc nanoparticles. A hydroxyapatite (Ca10(PO4)6(OH)2) nanoparticle could be a source of calcium and phosphate micronutrients, and it is utilized in surface alteration for the arrangement of nanohybrids. Concurring to the writing, hydroxyapatite (HA) has numerous biomedical and agricultural applications since of its fabulous bioactivity and biocompatibility. Urea may be a fertilizer that's broadly used in farming as a source of nitrogen supplements. Input of urea alone, the combination of hydroxyapatite nanoparticles with urea can perform double parts, that's, the moderate discharge of phosphorus and nitrogen fertilizers. The writing revealed that urea-modified hydroxyapatite nanoparticles with the capability of moderate and economical discharge increment the nitrogen agronomic effectiveness of plants and decrease the rate of deterioration of urea within the soil. Other than, there are distinctive sorts of micronutrients such as zinc, press, and copper that are basic for plant development and each has its application in the agricultural segment. Within the rural and green segments, the application of nanoparticles encompasses a comprehensive part in solid plant development. Among them, zinc is a fundamental micronutrient that produces development hormones and chloroplast. Iron nanoparticles have a potential part in plants as a fertilizer, because it can improve photosynthesis proficiency and nutrient retention. Copper nanoparticles play an important part as an antibacterial and antimicrobial specialist in the arrangement of chlorophyll, improving porosity and taking portion in a few chemical forms. The show work points to deliver HNF for the moderate and economical discharge of micronutrients that can be made accessible to soil and natural products. All tests are performed on ladies' finger plants for a comparative think about of arranged fertilizers with commercial fertilizers. It is appeared that this proposed fertilizer will dispense with the filtering issue of commercial fertilizers as well as decrease the dietary insufficiencies of the plant and give nutrient-rich natural products, which will offer assistance in lessening the dietary insufficiencies of human creatures.

II. MATERIALS AND METHODS:

Chemicals required: All of the chemicals utilized within the ponder were at their most noteworthy judgment. Calcium hydroxide (Ca (OH)2), Orthophosphoric Acid (H3PO4) and sodium hydroxide (NaOH). Trisodium citrate (Na3C6H5O7). Urea particles (CO(NH2)2) and other chemicals counting zinc chloride (ZnCl2), copper chloride (CuCl2), and ferrous chloride (FeCl2) and utilized without any advance filtration. Amid the exploratory period, ultrapure water was utilized for all of the arrangements and estimations.

Preparation of Cu, Fe and Zn Nanoparticles: NaOH (1.0 M) was broken up in refined water, and the arrangement was blended at 90 °C. A 0.5 M CuCl2 arrangement was included dropwise to the NaOH arrangement for 26 min. This time, the blend was mixed for 2 h at 90 °C and kept overnight to make a accelerate. The suspension was at that point sifted and washed with deionized water a few times. After washing, the suspension was dried at 70 °C to get Cu nanoparticles. Essentially, Fe and Zn nanoparticles were synthesized by the chemical precipitation strategy utilizing FeCl2 and ZnCl2, separately.

Preparation of Nano Urea Nanoparticles: Nano urea was arranged by blending urea atoms and trisodium citrate beneath ideal conditions. To begin with, 0.30 g of urea particles was blended with 0.86 g of trisodium citrate in a measuring utensil. The blend was at that point warmed steadily up to 90 °C for 1 h employing a hot plate. Trisodium citrate worked as a physiologically dynamic substance or nitrification inhibitor for nano urea generation. After completion of the warming prepare, the colour of the arrangement got to be fiery debris, showing the nearness of nano urea. Assist, the morphology of arranged nano urea was analysed by Scanning electron microscopy (SEM)

Preparation of Hydroxyapatite Nanoparticles: Hydroxyapatite nanoparticles were synthesized by utilizing a fluid arrangement of calcium hydroxide and orthophosphoric acid. A suspension of Ca (OH)2 (19.29 g, 250 mL of refined water) was arranged and permitted to blend for 25 min. By taking after the drop-cast strategy (10 mL/min), 250 mL of 0.6 M orthophosphoric acid arrangement was included from a burette to a Ca (OH)2 suspension and permitted to blend beneath mechanical agitation (1200 rpm) for 1 h. The coming about smooth arrangement was refrigerated for 24 h to get the accelerated hydroxyapatite nanoparticles.

Preparation of Nano Urea Modified Hydroxyapatite Nanoparticles: The treated suspension of hydroxyapatite nanoparticles (100 mL) was blended with 0.05 g of synthesized nano urea. The scattering was arranged beneath ultrasound sonication (30 kHz for 1 h). Besides, the blend was permitted to settle, and the overabundance fluid was depleted off. The coming about blend was assist centrifuged and washed three times with refined water. At long last, nano urea-modified hydroxyapatite nanoparticles were dried at 100 °C for 2 h and finely powdered with a hand mortar. The powder was characterized utilizing SEM, X-ray diffraction (XRD), and Fourier-transform infrared spectroscopy (FTIR).

Preparation of HNF: For the preparation of HNF, 3g of nano urea-modified hydroxyapatite nanoparticles was taken in a beaker and Cu, Fe and Zn Nanoparticles (5g each) were

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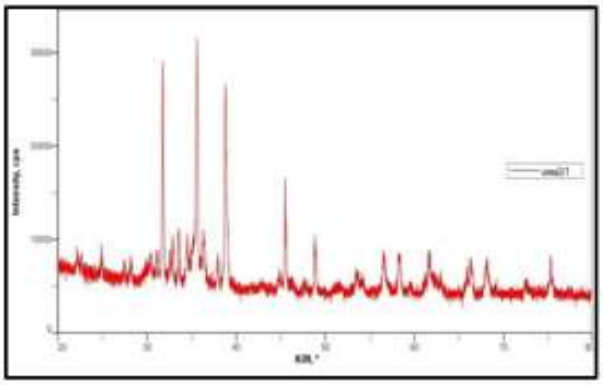
gently mixed together. The resulting HNF was stored in an airtight container for further use.

Treatment of HNF on Abelmoschus esculents: For the explore, soil and different sorts of plants were collected from a nearby tree nursery. A. esculentus was treated to guarantee the adequacy of the arranged HNF. Differential behaviour was analysed by applying 50 mg of synthesized HNF, and 5 g of commercial fertilizer was independently connected to A. esculentus plants.

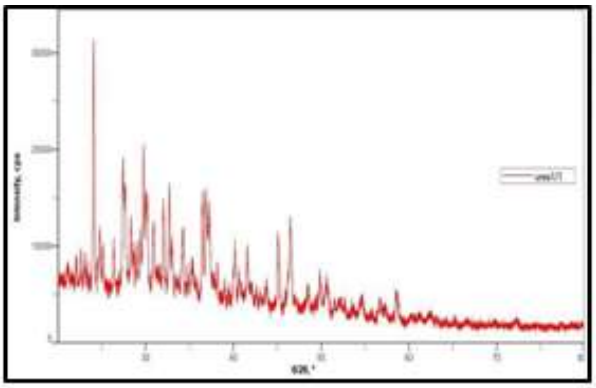
Characterization of HNF:FTIR spectroscopy was utilized to recognize the presence of a functional group within the HNF. To explore the basic behaviour and the arrangement of the HNF, an XRD consider was performed. SEM pictures were taken to watch the surface morphology and calculate the estimate of different nanoparticles.

III. RESULTS AND DISCUSSIONS:

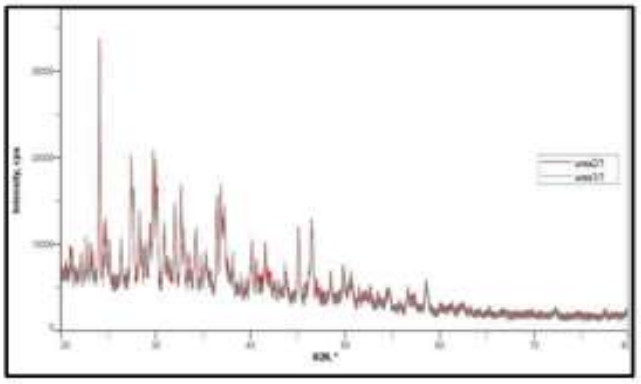
Characterization of HNF: The powder X-ray diffraction (XRD) design of the nano urea-modified HA nanoparticles is appeared. XRD was performed to decide the crystalline nature of the nano urea-modified Hydroxy apatite



XRD Results of UREA sample-1

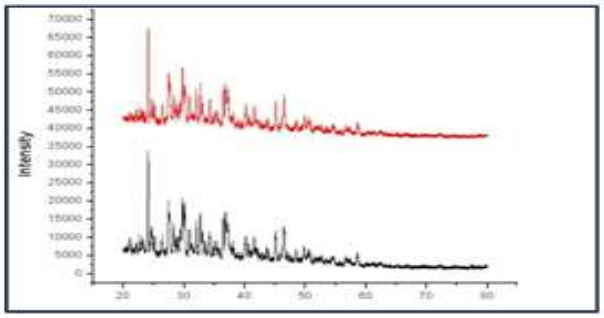


XRD Results of UREA sample-2

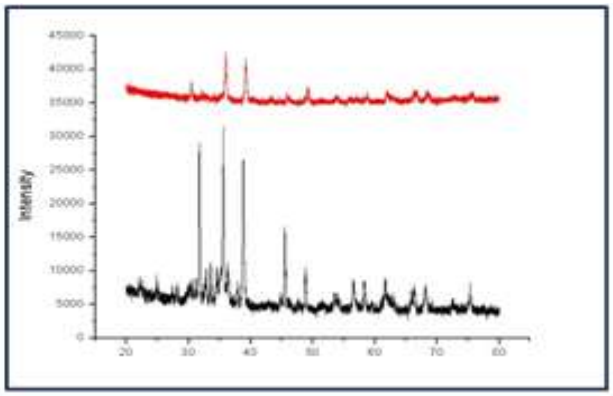


XRD Results of Cu,Fe and Zn nano particles

nanoparticles. From the XRD chart, the crests watched at 2θ values of 25.9, 32.04, 32.98, and 34° are comparing to the reflection plane structure of the crystalline HA nanoparticles. The XRD design of unadulterated urea appeared lower-intensity crests at 23, 25, 32, 36, and 37°. Due to the solid intuitive of urea with the HA nanoparticles, the concentrated of the top at the 2θ esteem of 22.1° compares to the noteworthy breakdown of the crystalline structure of urea. The discoveries propose that conspicuous holding modes are metal–ligand intuitive between Nmolecules in urea and Ca iotas in HA nanoparticles.

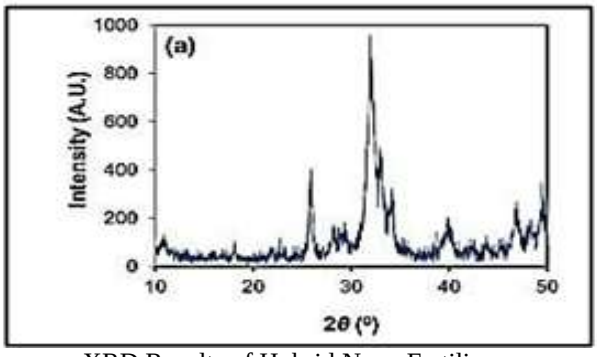


XRD Analysis of Urea Nano particles



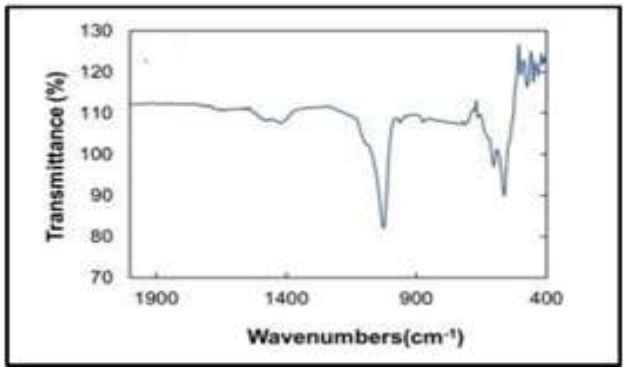
XRD Analysis of Cu,Fe and Zn Nano particles

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XRD Results of Hybrid Nano Fertilizer

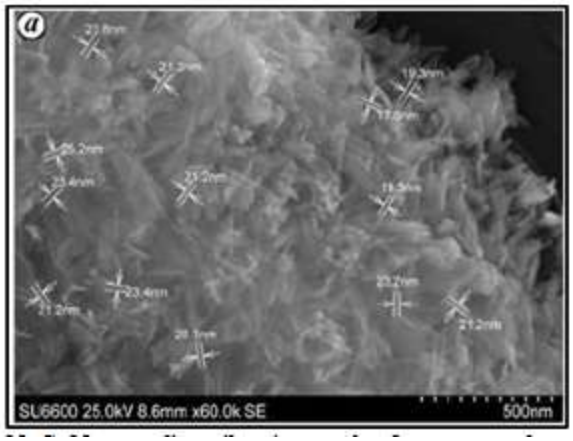
FTIR retention range of the synthesized urea-modified HA nanoparticles is appeared in Figure 1b. The P–O extending of PO43– particles in hydroxyapatite was spoken to as a sharp escalated top with the wave number esteem of 1050 cm–1. After the alteration handle, the N–H bowing movement of urea moved from 1593 to 1614 cm–1. This move shows the nearness of free N–H bonds within the urea-



FTIR analysis of hybrid nano fertilizer

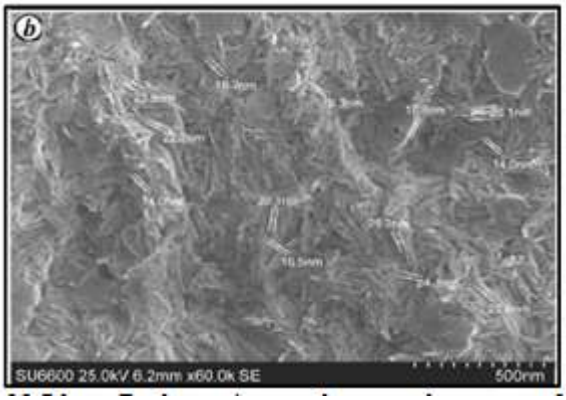
modified HA nanoparticles. The carbonyl extending vibration is watched at 1657 cm–1 in urea-modified HA nanoparticles. Usually credited to influencing the C═O bunch allotted to the N–H hydrogen holding of HA. It is worth saying that the N–C–N extending vibration peak of urea moved to a lower escalated of 472 cm–1 within the urea-modified HA nanoparticles.

SEM investigation was conducted to urge knowledge into the morphologies of the synthesized nano urea and nano urea-modified HA nanoparticles, which are displayed. Concurring to the examination, nano urea particles were of diverse sizes and had a Fiber like structure. The normal

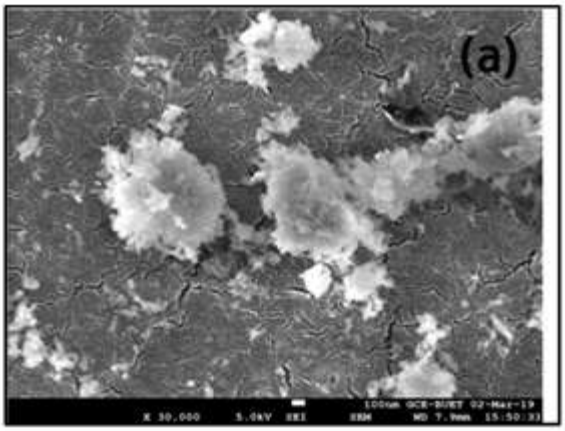


Morphological analysis of synthesized hydro xyapatite nano particles by SEM

Morphological analysis of syn the sized hydroxyapatite nano particles by SEM measure of nano urea particles was calculated to be 39.76 nm. Be that as it may, the normal measure of the urea-modified HA nanoparticles was calculated to be 38.21 nm.

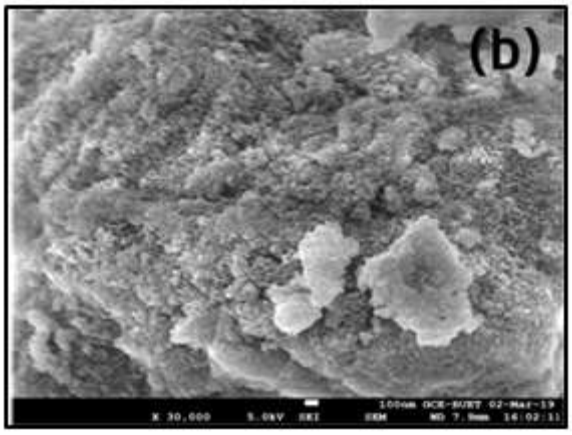


Morphological analysis of urea modified hydro xyapatite nano particles by SEM



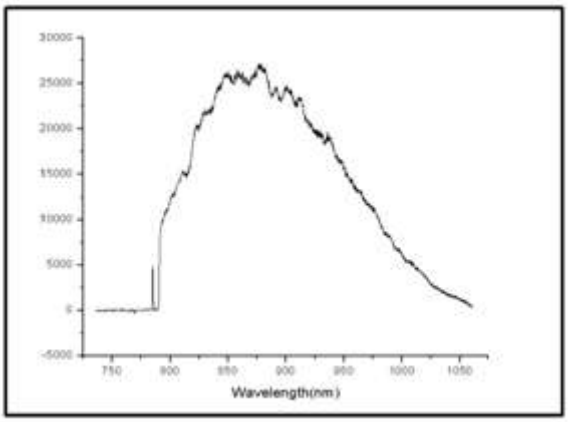
Morphological analysis of Synthesized nano urea by SEM

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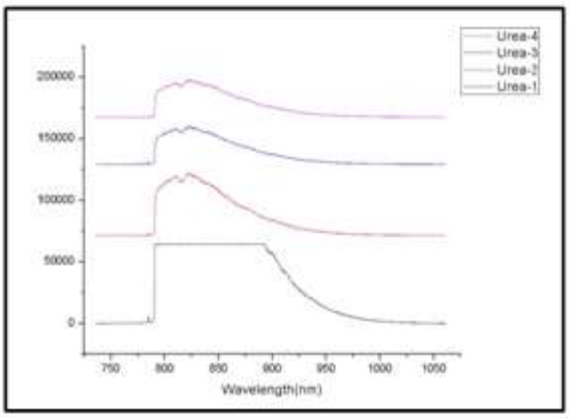


Morphological analysis of Nano urea modified hydroxyapatite nano particles by SEM

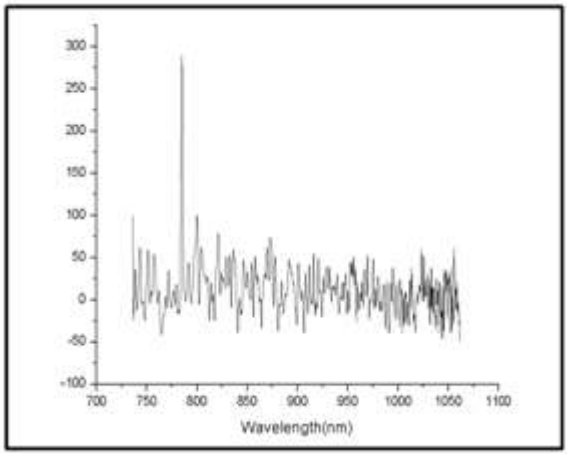
Raman analysis was conducted to study and observe the crystalline structure and the highest peaks of the prepared nano particles.



Vibrational analysis of Cu,Fe and Zn nano particles by Raman spectroscopy

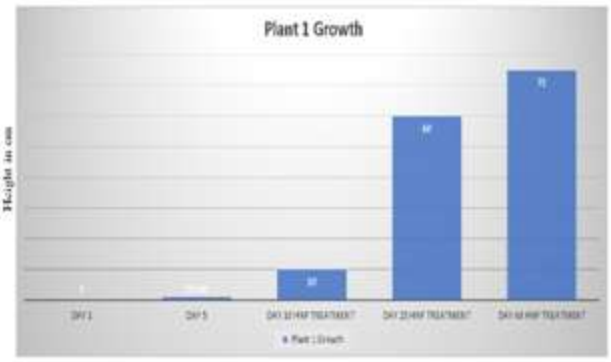


Vibrational analysis of urea nano particles by Raman spectroscopy

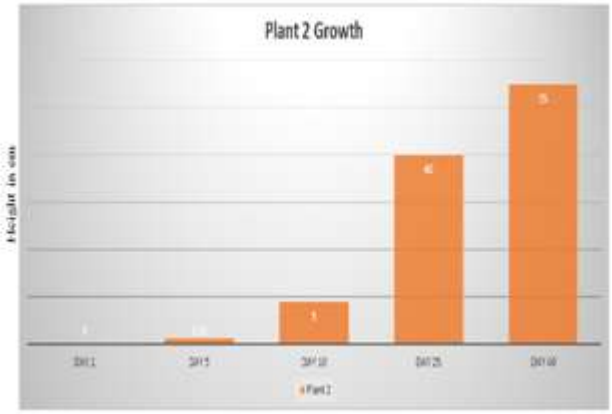


Vibrational analysis of Hybrid Nano Fertilizer by Raman spectroscopy

Plant growth Analysis: To study the HNF, the fertilizer is used on okras plant (lady's finger) with treatment on plant 1 and with no treatment on plant 2.



HNF treatment with tap water



Tap water with no treatment of HNF

IV. CONCLUSIONS:

We have successfully synthesized HNF that is functionally valuable for the slow and sustained release of urea and nutrients into the soil. Our result suggests that HNF has potential for a slow release of Ca^{2+}, PO_4^{3-}, NO^{2-}, NO^{3-}, Cu^{2+}, Fe^{2+}, and Zn^{2+} nutrients. This nano fertilizer was applied on Abelmosch uses culentus and showed maximum nutrient use efficiency and higher yields. It was noticed that HNF increases Cu^{2+}, Fe^{2+}, and Zn^{2+} nutrient uptake efficiency more than the commercial fertilizer within a few days. The slow-release study of HNF was conducted for up to 14 days. This work concluded that HNF has great advantages as a fertilizer including the slow and sustainable nutrient release, low dosing (50 mg/week), low cost, nutrient-rich fruits, and negligible land contamination.

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