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Characterisation and Analysis of Nanosized Fertilizers and their Effect on Cereal Plants

Nethravathi M[1], Divya KH[1], Prashanth Kumar HP[1], Saranya D[1], Shashidara KS[2]*

[1]Department of Biotechnology, Sapthagiri College of Engineering, Bangalore-560057, India
[2]Department Of Genetics and Plant Breeding, College of Agriculture, Hassan, Karnataka, India

Abstract : Nanotechnology has been evolved as a great tool in almost all the disciplines of science and technology. It has its major contributions in the field of agriculture, disease diagnosis, medicine and industry. Nanofertilizers, nanoherbicides, nanopesticides have a great impact on the growth and yield of crop plants. This is due to their smaller size which has made them possible to penetrate easily into the plant body through small pores present on plant body. In this paper, investigation was done to study the effect of nanosized chemically synthesized particles on the plant growth and development. Chemically synthesised fertilizers in granule form were grinded to powder form. Further characterization studies were performed to confirm the particle size of fertilizer. Sterilized soil and seeds were used to nullify the effect of microorganism which may affect the plant growth. A comparative study was done between the plants grown by utilizing nanosized fertilizers and granules. The main objective of this study is to make the fertilizers available to crop plant effectively thereby increasing the uptake of them. These in turn reduces the loss of fertilizers by the supply of balanced and sufficient amount of them in nanosize.
Keywords: Nanotechnology, Nanosized fertilizers, sterilized soil, granules, seeds.

1. Introduction:

Agriculture is backbone for national economy. Technology is applied on agriculture to obtain better yield, decrease the product price and improve nutrition and to reduce the hazardous effect of certain chemicals[1]. In this route of development in agriculture sector nanotechnology has been stood forward. Nanotechnology has its unique physical property of tiny particle size which enables it to give novel application in agriculture field. Nanotechnology enhances the plant growth by monitoring them and protects the plants by detecting the diseases. Along with this it also increases the food productivity and quality[2]. In addition to these nanoparticles helps in rapid seed germination and early seedling[3]. When the particles are in nanoscale they show enormous, extraordinary properties which are not possible in the case of large sized particle[4]. It is possible by nanotechnology to study the mechanism of plant diseases by examining the interactions between pathogens responsible for causing disease and the organelles of plant cell[5]. For the efficient transportation of chemicals such as fertilizers, growth regulators, herbicides, insecticides etc, nanoparticle acts as vector[5, 6].

Unsystematic use of fertilizers leads to environment pollution when it enters the water body and affects the biodiversity[8]. In order to overcome this effect, only sufficient amount of required fertilizers should be provided. We narrowed our focus on the fertilizers in this study. The fertilizers that are in the form of granules which were already synthesized chemically by industries and available in market were brought down to nanoscale by grinding them mechanically using pestle and mortar. We considered 4 different types of fertilizers that are water soluble in nature. Since they are in granule form it is difficult for the roots of the plant to absorb through small pores present in them. This leads to excess supply of fertilizers. By transforming these fertilizers to nanoscale and then supplying them to plants increases the uptake of fertilizers through small pores present in roots, this was made possible because of the small size. This in turn minimizes the supply of fertilizers thereby maintaining the biodiversity and reducing the pollution. A comparative study was done between the plants grown using fertilizers in granule form and fertilizers in nanoscale against the control.

2. Experimental Methodology:

A. Collection of Fertilizers and Grinding:

Four varieties of water soluble chemically synthesized fertilizers were considered. These fertilizers mainly consist of nitrogen and phosphorus as composites. These fertilizers were subjected to grinding using pestle and mortar in order to bring them to nanosize.

Table.1: Fertilizers and its composites

Sl No	Fertilizer	Composition	Company
1	Urea	46% N	IFFCO
2	Diammonium Phosphate (DAP)	N – 18.0%, P_2O_5(T) - 46.0%, P_2O_5(CS) - 46.0%, P_2O_5(WS) - 41.0%,	SPIC
3	NPK 17-17-17	N – 17.0%, P– 17.0%, K(WS) – 17.0%	VIJAY
4	NPK 10-26-26	N – 10.0%, P(T) – 26.0%, P(CS) - 26.0%, P(WS) – 22.1%, K(WS) – 26.0%	IFFCO

B. Characterization Test:

UV spectrophotometer analysis was done to characterise the grinded fertilizer samples to confirm the size which was expected to be nano scale. Lorentzian profile of absorption obtained from Mietheory shows that the size of nanoparticles is related to width of absorption profile[8] and hence showed that the particles were in nano scale when position peak is between 350 to 420nm. UV spectra of all the four fertilizer samples were obtained [Fig 1-4].

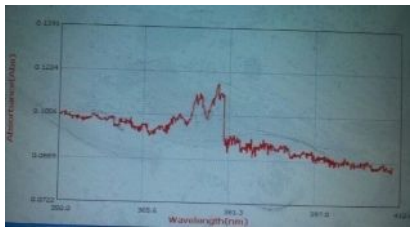


Fig.1: UV Spectra of Urea

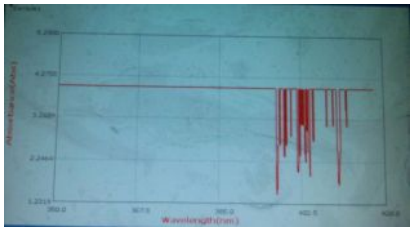


Fig.2: UV Spectra of DAP

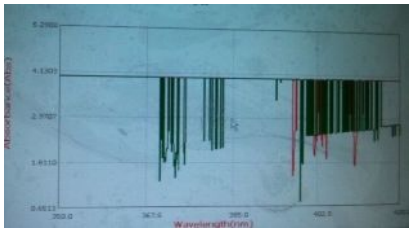


Fig.3: UV Spectra of NPK 17-17-17

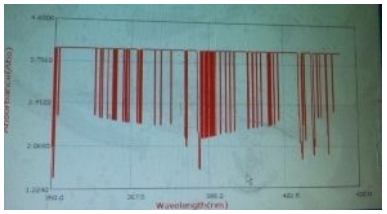


Fig.4: UV Spectra of NPK 10-26-26

C. Seeds collection:

Cowpea seeds of variety 'Arka Suman' were procured from Indian institute of Horticulture Research, Hesaraghatta, Bangalore, Karnataka, India. Uniform sized seeds were selected to minimize errors in seed germination.

D. Sowing the seeds:

In order to examine only the effect of fertilizers, initially the soil was sterilized by autoclaving. This was performed in the intension to kill the microorganisms that may have effect on the growth and development of plant i.e., those microorganisms may support the growth of plant or inhibit the growth. Hence by sterilizing the soil their effect was nullified. Totally 9 pots were considered, 4 pots for fertilizers in nanoscale, 4 pots for fertilizers in granule form and 1 as control i.e., without any fertilizer. After autoclaving the soil was cooled and then the seeds were sowed. All the 9 pots were sown with uniform sized seeds. 5 seeds were sown in each pot after which the average of all the 5 was considered.

E. Supply of fertilizers:

First day after sowing the seeds, the first 4 pots F1, F2, F3 and F4 [Table 2] were sparyed with 10ml of 0.5% solution of fertilizers of nanoscale (i.e., by dissolving 0.5 gram of grinded powder in 10ml of distilled water) and the next 4 pots S1, S2, S3 and S4 [Table 2] were supplied with 10ml of 0.5% solution of fertilizers in granule form (i.e., by dissolving 0.5 gram of granules in 10ml of distilled water). The control was fed only with 10ml of water. Second day after sowing the seed, sprouting of seeds took place [Fig. 5].

Table.2: Naming of fertilizers used

F1	Urea in nanoscale
F2	DAP in nanoscale
F3	NPK 17-17-17 in nanoscale
F4	NPK 10-26-26 in nanoscale
S1	Urea in granule form
S2	DAP in granule form
S3	NPK 17-17-17 in granule form
S4	NPK 10-26-26 in granule form

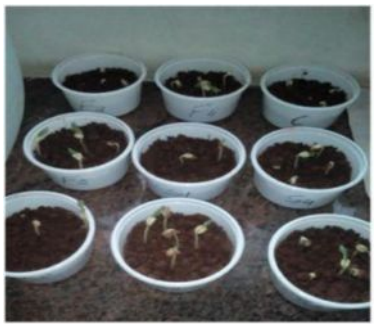


Fig. 5: Sprouting of seeds

Fig. 6: Growth of plants observed on fifth day

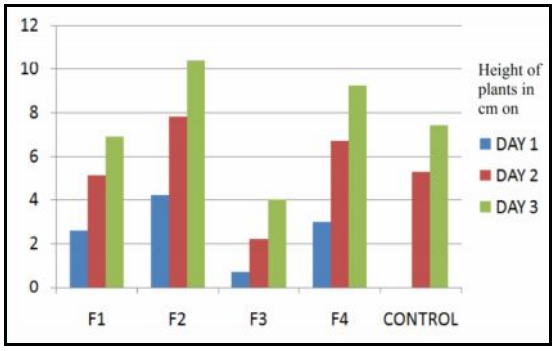
Fig. 7: Measurement of root length

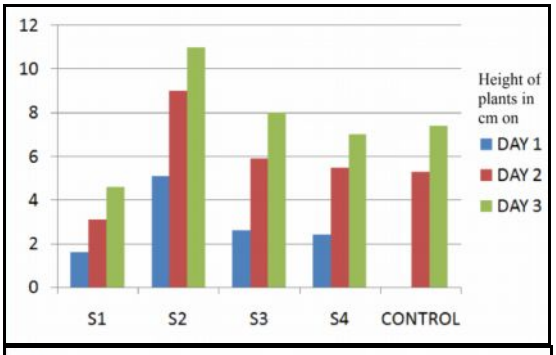
Fertilizers were supplied on the alternative days. 10ml of only water was supplied on the second day to all the pots. On third day, all the 8 pots were subjected to supply with 10ml of 0.5% fertilizer solution and control pot with water. Fourth and fifth day, all the pots were supplied with 10ml of water. The heights of plants were measured every day (day 3, day 4 and day 5). The average of all the 5 plants in each pot was considered and tabulated. Fig.6 shows the growth of plant on the fifth day after sowing the seeds. On the day 5, the plants were uprooted.

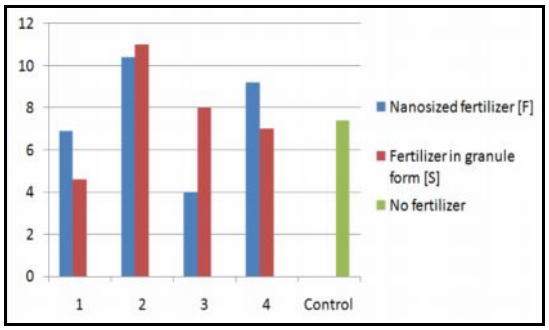
The length of roots were measured [Fig. 7] and tabulated. Along with these, the number of root hairs were also counted and tabulated.

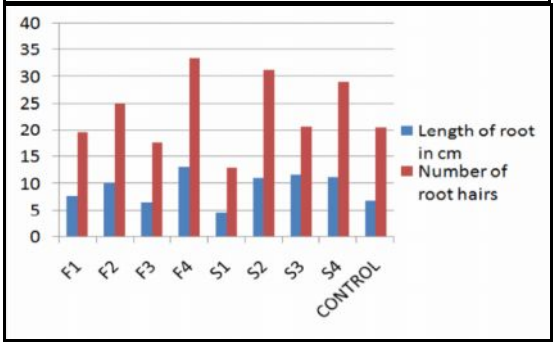
3. Results and Discussion:

The graphs were plotted for the height of the plant on all the 3 days (day 3, day 4 and day 5). Graph 1 was plotted for heights of plants grown by spraying fertilizers in nanoscale (F1, F2, F3 and F4). Graph 2 was plotted for heights of plants grown using fertilizers in granule form (S1, S2, S3 and S4). Graph 3 was plotted for comparing the height of plants grown using nano sized fertilizers and fertilizers in granule form on day 5. Graph 4 was plotted for length of roots and number of root hairs present.









Graph 1: Height of Plants Grown by spraying nanosized fertilizer
Graph 2: Height of Plants Grown using Fertilizers in granule form
Graph 3: Comparison between heights of Plants Grown using nano sized fertilizers and fertilizers in granule form on day 5
Graph 4: Length of Roots and Number of Root Hairs present

The graph 1 shows that the height of plant grown F2 and F4 was more compared to the control. The graph 2 shows that the height of plant grown S2 and S3 was more compared to the control. The graph 3 shows that the height of S2 was greater than F2 and control and also height of F4 was greater than S4 and control. As the length of roots and number of root hairs increases, the absorption of fertilizer increases which in turn increases the plant growth[9]. The graph 4 shows that the length of roots and number of root hairs are greater in F4, S2, S4 and F2 than that of control

4. Conclusion:

The growth rate of plant was found to be more when fertilizers were used in nano scale compared to the growth rate of plant with normal fertilizers.

5. **Future Work**:

The growth rate of other plants will also be studied with nano scale fertilizers.
Other variety of fertilizers available in market will also be considered and studied.

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