Journal of Advanced Scientific Research

Available online through http://www.sciensage.info

ISSN
0976-9595
Research Article

COMPARATIVE ROLE AND EFFICIENCY OF NPK ADSORBED POLYMERIC AND METALLIC NANOFERTILIZER ON THE GROWTH CHARACTERISTICS OF *EPIPREMNUM AUREUM*

Remya Madan Gopal

Pillai HOC College of Arts, Science and Commerce, Rasayani, Raigad, Maharashtra, ndia

**Corresponding author: remyagopal@mes.ac.in*

ABSTRACT

The unabashed use of synthetic chemical (NPK or nitrogen, phosphorus and potassium) fertilizers worldwide is slowly but surely leading to an environmental disaster and seriously jeopardizing human health with many a cancer attributed to the bio-accumulated toxic effect of such chemical fertilizers in our body. Biological applications of nanotechnology is referred to as nanobiotechnology. It may be impossible to completely do away with NPK fertilizer application but nanoparticulate form of NPK fertilizers may be a positive solution to nullify their adverse effects. In the present study, *E. aureum* were grown in bottles with regular tap-water without using any special hydroponic media. Predetermined doses of NPK adsorbed nanoparticles were added to the water media. Plant growth parameters like length of shoots and roots, moisture content, chlorophyll content, yellowing of leaves etc. were noted. The test *Epipremnum aureum* plants had significantly higher shoot and root growth at a 1/10th concentration of NPK adsorbed nanoparticles which was significantly higher ($p<0.05$) than that of NPK fertilizers applied directly at 10 times higher dose. The study thus shows that application of NPK fertilizers in nanoparticulate form reduces the required doses, nutrient losses, results in better growth characteristics and does not cause ant untoward plant toxicities.

Keywords: Nano-fertilizers, SPIONs, Polymeric Nanoparticles, Nanotechnology, Inorganic fertilizers.

1. INTRODUCTION

As the world population keeps on burgeoning, the arable land area is not increasing proportionately but the pressure to feed the hungry mouths has resulted in the indiscriminate and uncontrolled application of inorganic chemical fertilizers for higher agricultural and horticultural yields [1]. Many severe modern day health hazards like cancer can be attributed to the practice of application of synthetic fertilizers which biomagnifies as we move higher in the food chain. Apart from this serious issue, the use of these chemicals causes loss of soil fertility and soil microbial population. The cost index of resulting crops is also higher and the run-off from the farmlands results in severe environmental pollution. Nanobiotechnology is a relatively new specialized entrant and promises to revolutionize agricultural and horticultural practices globally [2]. Dose sparing is a hallmark of nanobiotechnology and it can both enhance yields while mitigating nutrient losses because of the much higher surface to volume ratio and bringing in the concept of nanofertilizers, although full scale industrial production and application has not been achieved everywhere around the globe [3, 4].

A plethora of different types of nanoparticles (NPs) are being studied for nanofertilizer application. NPK fertilizers may be entrapped inside or adsorbed on surface of such nanoparticles [5, 6]. The test plant for the current study was *Epipremnum aureum* which is a very hardy evergreen plant requiring little care and is found distributed widely across many Asian countries. It is a common ornamental indoor plant because of its beautiful variegated leaves and it can stay green even in the absence of direct sunlight [7]. For this study, *E. aureum* were grown in bottles filled with regular tap-water. Predetermined doses of NPK adsorbed nanoparticles were added to the water media. Important parameters of plant growth like length of shoots, roots, chlorophyll content etc. were measured.

2. MATERIALS AND METHODS

2.1. Synthesis of iron oxide nanoparticles (SPIONs)

A 200 µL Tween 80 was added to 10mL 3% ferrous sulphate solution (w/v) to form a clear solution in nitrogen atmosphere. 0.1% (w/v) Sodium hydroxide was added dropwise under nitrogen atmosphere and ice-cold conditions. A blue-green precipitate appeared which was stirred for approximately two hours. Centrifugation at 15,000 rpm was carried out for 30 minutes and resulting brown-coloured precipitate was then further heated to approximately 60°C to obtain a brownish-black powder of SPIONs

2.2. Synthesis of poly-ε-caprolactone nano-particles by double emulsion solvent evaporation method

As previously described [8], the oil phase consisted of 50mg of poly-ε-caprolactone polymer (Mw.14KD) dissolved in 10ml acetonitrile. The water phase contained 50mg Pluronic F127 dissolved in 20ml distilled water. The oil phase was added to the water phase slowly under constant stirring. The o/w emulsion was kept until acetonitrile evaporated with the formation of poly-ε-caprolactone nanoparticles.

2.3. Effect of unloaded and NPK adsorbed iron oxide and poly-ε-caprolactone nano-particles on growth of *Epipremnum aureum*

Stem cuttings of *E. aureum* of initial identical length of 15cm were taken. The stem cuttings were kept in glass bottles filled with 200ml normal non-chlorinated tap water. Samples were grouped as treated with NPK fertilizer (positive control), without any NPK treatment or treated only with PCL NP and SPION without NPK (negative control), experimental test samples (treated with NPK adsorbed PCL and SPION NPs). 3 stem cuttings per group were taken for the study. The NPK fertilizer brand had an equal 10:10:10 ratio of nitrogen: phosphorous and potassium. Positive controls were treated with NPK fertilizer at a dose of 2gm/200ml per bottled plant. Experimental groups were treated with 0.2gm/200ml per bottle.

Physical observation of plant growth was monitored at an interval of 7 days. The plants were monitored by measuring the root and shoot length manually using a measuring scale.

2.4. Moisture Content

Weight of fresh leaves gave the wet weight of the leaves. The leaves were then dried in an oven for 30 min. Dried leaves of *E. aureum* were powdered, weighed after cooling and percentage of moisture content calculated as per the formula:

$$\text{Moisture content (\%)} = \frac{\text{wet weight} - \text{weight after drying}}{\text{wet weight}} \times 100$$

2.5. Chlorophyll Content

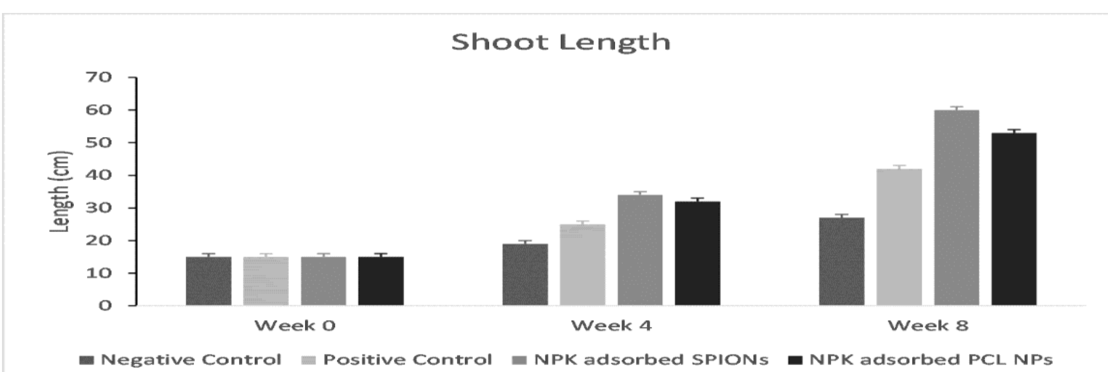
For the estimation of chlorophyll content, 0.15gm fresh leaves of *Epipremnum aureum*, after washing with tap water followed by distilled water, was homogenized with chilled 80% acetone using mortar- pestle. The homogenized sample was centrifuged at 4500 rpm for 5 min. After centrifugation, the supernatant was removed and again washed with 8ml 80% acetone at 3000 rpm for 5 min. This procedure was repeated until sample color became transparent. The sample was kept in dark and reading noted at 645 nm and 663 nm.

Formula: Total chlorophyll content (μg/ml) = 20.2 (Absorbance at 645) + 8.02 (Absorbance at 663).

3. RESULTS AND DISCUSSION

3.1. Growth Characteristics

NPK adsorbed nanoparticles when applied to the test plants showed more growth of shoots and roots compared to negative control when measured. The initial shoot lengths of test and control groups were 15cm. at the end of 4^{th} week, the shoot lengths were 34±1.8cm and 32±2.3cm and at the end of 8^{th} week were 60±1.1cm and 53±2.7cm for groups treated with NPK adsorbed SPIONs or NPK adsorbed PCL NPs, respectively (Fig. 1).



The test groups with NPK adsorbed SPIONs and PCL NPs show significantly higher shoot lengths. ($p<0.05$)

Fig. 1: Plant shoot lengths of various groups at week 0, week 4 and week 8.

The increase in mean shoot length was significant ($p<0.05$) compared to the positive control plants given NPK fertilizer directly. Root length measurements yielded a similar result.

3.2. Moisture and chlorophyll content

For the doses tested in this study, there was no significant difference observed in moisture content between the test plants grown in presence of NPs and in negative control plants grown in absence of NPs ($p>0.05$) (Fig. 2). Also, measurement of chlorophyll content of *Epipremnum aureum* grown in presence or absence of NPs did not reveal any significant difference which may be interpreted as an indication that the nanoparticles do not cause detrimental toxicity within the test dose range (Fig. 3).

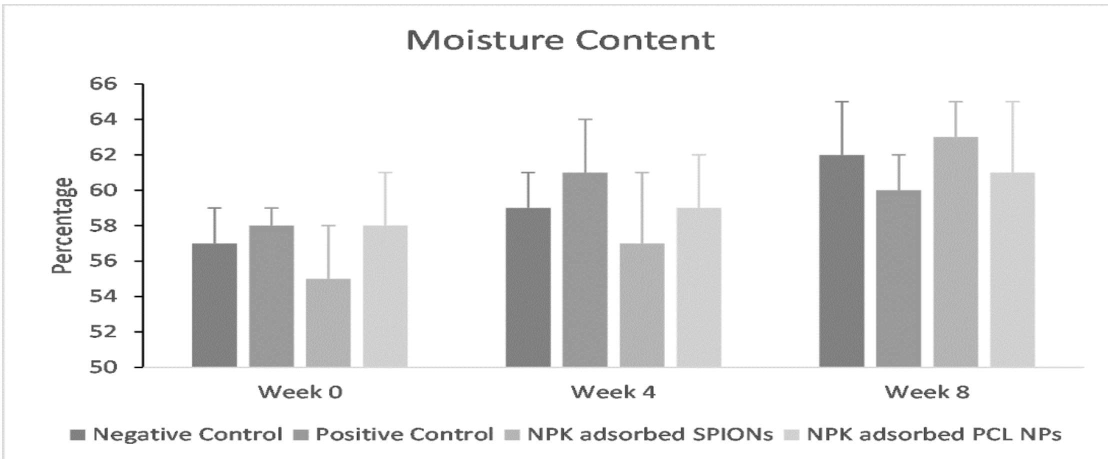


Fig. 2: Moisture content measured at week 0 to 8 did not vary significantly between the experimental groups

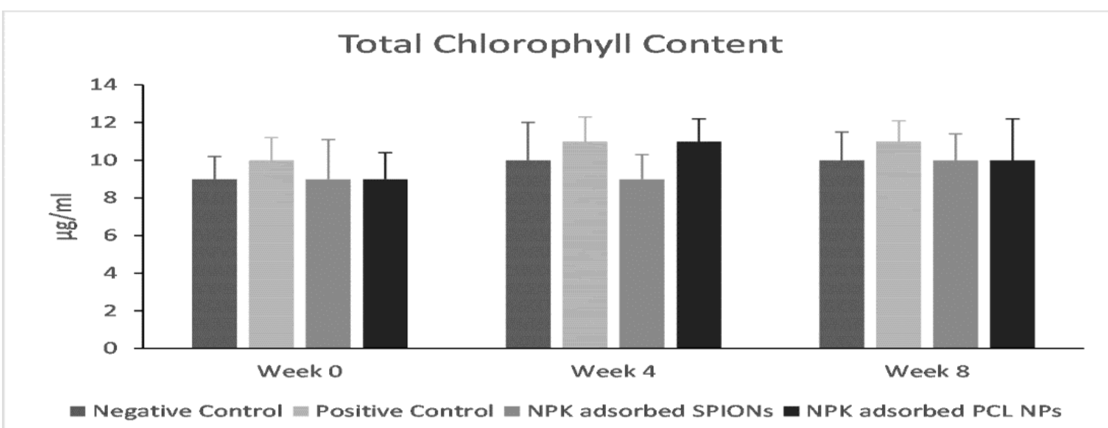


Fig. 3: Chlorophyll content measured at week 0, week 4 and week 8 did not vary significantly between the test and control groups

4. CONCLUSION

The study effectively demonstrates the dose-sparing ability and higher yields of inorganic NPK fertilizers applied in nanoparticulate form without any adverse effects on the plants compared to routinely applied NPK fertilizers. Iron oxide and PCL NPs at the tested doses do not cause any major injury to the plants.

5. ACKNOWLEDGMENT

The author extends thanks to University of Mumbai for the minor research grant that financially supported this study.

Conflict of interest

The author declares that there are no conflicts of interest for the associated research data.

6. REFERENCES

1. Basavegowda N, Baek KH. *3 Biotech,* 2021; **11**:357.
2. Raliya R, Saharan V, Dimkpa C, Biswas P. *J Agric Food Chem*, 2018; **66**:6487-6503.
3. VandeVoort AR,Arai Y. *Nanomaterials,*2018; **8**:927.
4. Lowry GV, Avellan A, Gilbertson LM. *Nat Nanotechnol*, 2019; **14**:517-522.
5. Sekhon BS. *Nanotechnol Sci Appl,* 2014; **7**:31-53.
6. Pradhan S, Mailapalli DR. *J Agric Food Chem*, 2017; **65**:8279-8294.
7. "Epipremnum pinnatum". Natural Resources Conservation Service PLANTS Database. USDA. Retrieved December 6, 2015.
8. Prashant CK, Bhat M, Srivastava SK, Saxena A, Kumar M, Singh A et al. *Int J Nanomedicine*, 2014; **9**:937-950.