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Research Article

# EVALUATION OF NANO-FERTILIZER WITH INTEGRATED NUTRIENT MANAGEMENT IN BT. COTTON (*Gossypium hirsutum* L.) UNDER RAINFED CONDITION

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**Abstract:** A field experiment was conducted on medium black soil to study the evaluation of nano fertilizer in Bt. cotton (*Gossypium hirsutum* L.) under rainfed condition at Dry Farming Research Station, Junagadh Agricultural University, Targhadia, Gujarat, during *kharif*- 2017-18 to 2020-21. The experiment comprising of six treatments *viz*., $T_1$. 80 kg N ha$^{-1}$ through urea, $T_2$. 1/10 (8 kg N ha$^{-1}$) RDN through nano fertilizer, $T_3$. 1/5 (16 kg N ha$^{-1}$) RDN through nano fertilizer, $T_4$. 1/2.5 (32 kg N ha$^{-1}$) RDN through nano fertilizer, $T_5$. Backbone polymer fragment liquid only as $T_2$, $T_6$. 80 kg N ha$^{-1}$+ 10 tonne compost ha$^{-1}$ + 500 kg castor cake ha$^{-1}$ with four replications laid out in randomized block design. In pooled results, on growth and yield attributers *viz*., number of monopodia, sympodia and balls per plant and ball girth at maturity, root, stem, leaf, open ball growth rate and crop growth rate was found significant during all the four years, whereas partitioning percentage was found non-significant during all the four years. Similarly, seed cotton and stalk yield of Bt. cotton was found significant during all the four years. Maximum net realization (Rs. 109147 ha$^{-1}$) was obtained under application of 80 kg N ha$^{-1}$ through urea, followed by under application of 80 kg N ha$^{-1}$ + 10 tonne compost ha$^{-1}$ + 500 kg castor cake ha$^{-1}$(Rs. 104025 ha$^{-1}$) and 1/2.5 (32 kg N ha$^{-1}$) RDN through nano fertilizer.

**Keywords:** *Bt. Cotton, Nano fertilizer, INM, Yield Attributes and Economics*

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## Introduction

Cotton (*Gossypium* sp.) is grown as an important fiber crop in India belongs to Malvaceae family and called "*King of Fiber*" and "*White gold*" plays a prominent role within the rural, national and international economy. It's grown mostly for fiber utilized in the manufacture of cloths for mankind. Besides fiber, cotton is additionally valued for its oil (15-20%) which are used as edible fat and soap industries. Cotton seed cake is incredibly rich protein used as cattle feed and as manure, which contain 6.4, 2.9 and 2.2 per cent N, P and K, respectively. India may be a major producer of cotton. India stands first position in area and third in its production. In India it's grown over a vicinity of 122.38 lakh hectares with production of 361.00 lakh bales and productivity of 501 kg/ha [1].

Nano-technology opens a large scope of novel application within the fields of biotechnology and agricultural industries due to nano-particles (NPs) have unique physiochemical properties, *i.e*., high extent, high reactivity, tunable pore size and particle morphology [2]. The foremost important properties of those nano-particles (NPs) are their size which might manipulate the physiochemical and optical properties of a selected substance [3,4]. Endophytic methods earned more attention within the field of medical, pharmaceuticals, environmental and agronomical applications [5,6]. It's been found that NPs play a significant role as delivery systems in agricultural research for the development of crops [7]. NPs as delivery systems are applied in agricultural applications for the development of crops by studying their effect on plant growth, metabolic functions, and genetic transformation. Nano-encapsulated chemicals for agricultural purposes should be planned in an exceedingly manner to indicate less eco toxicity, effective concentration, high stability, solubility, time-control, and to boost their targeted activity when certain stimuli occur [8]. Nano-particles can function "magic bullets" containing fertilizers or genes, which target specific cellular organelles in plant to release their content.

Despite the many information available on the toxicity of nano-particles to plant system, few studies are conducted on mechanisms, by which nano-particles exert their effect on plant growth and development. Therefore, this review highlights the key role of nano-particles in plants. Nanotechnology has large potential to produce a chance for the researchers of plant science and other fields, to expand latest tools for incorporation of nano-particles into plants that would augment existing functions and add new ones in agriculture [9]. Moreover, nano science contributes new ideas leading us to grasp the acceptable mode of action of nano-particles in plants. The acceptable elucidation of physiological, biochemical and molecular mechanism of nano-particles in plant results in better plant growth and development.

## Materials and Methods

The experiment was conducted on medium black soil of main dry farming research station, of Junagadh Agricultural University, Targhadia, Gujarat during four consecutive *kharif* seasons of 2017-18 to 2020-21. The year wise total rainfall received during the crop growth seasons 2017-18 to 2020-21 were 1328.5, 613.6, 1360.4 and 1160.4 mm, with 38, 26, 41 and 45 rainy days, respectively. Some important characteristics of the soil were pH 8.27, EC 0.27 dS/m, Organic carbon 0.49 %, available N, P and K were 208, 32.32, and 240 kg/ha, respectively. The experiment comprises six treatments. $T_1$. 80 kg N ha$^{-1}$ through urea, $T_2$. 1/10 (8 kg N ha$^{-1}$) RDN through nano fertilizer, $T_3$. 1/5 (16 kg N ha$^{-1}$) RDN through nano fertilizer, $T_4$. 1/2.5 (32 kg N ha$^{-1}$) RDN through nano fertilizer, $T_5$. Backbone polymer fragment liquid only as $T_2$, $T_6$. 80 kg N ha$^{-1}$+ 10 tonne compost ha$^{-1}$ + 500 kg castor cake ha$^{-1}$. The experiment was laid out in randomized block design with six treatments with four replications and individual plot size of 6.0m x 6.3m (gross) and 3.6m x 3.6m (net).

Table-1 *Yield and economics of Bt. cotton as influenced by different treatments of nano-fertilizer (Pooled data-2017 to 2020)*

| Tr. No. | Treatment | Yield (kg ha$^{-1}$) | | Gross | Total cost of cultivation | Net realization |
|---|---|---|---|---|---|---|
| | | Seed Cotton | Stalk | Realization (Rs./ha) | (Rs./ha) | (Rs./ha) |
| $T_1$ | 80 kg N ha$^{-1}$ through urea | 2631 | 4402 | 146906 | 37759 | 109147 |
| $T_2$ | 1/10 (8 kg N ha$^{-1}$) RDN through nano fertilizer | 2062 | 3450 | 115135 | 36279 | 78856 |
| $T_3$ | 1/5 (16 kg N ha$^{-1}$) RDN through nano fertilizer | 2202 | 3512 | 122866 | 38688 | 84178 |
| $T_4$ | 1/2.5 (32 kg N ha$^{-1}$) RDN through nano fertilizer | 2572 | 4270 | 143595 | 43505 | 100090 |
| $T_5$ | Backbone polymer fragment liquid only as $T_2$ | 1973 | 3232 | 110131 | 36059 | 74072 |
| $T_6$ | 80 kg N ha$^{-1}$ + 10 tonne compost ha$^{-1}$ + 500 kg castor cake ha$^{-1}$ | 2752 | 4647 | 153684 | 49659 | 104025 |
| S. Em.± | | 79 | 136 | | | |
| C.D. at 5% | | 224 | 385 | | | |
| C.V.% | | 13.4 | 13.9 | | | |

Table-2 *Effect of nano fertilizer on growth parameters and partitioning percentage of Bt. cotton (Pooled data-2017 to 2020)*

| Tr. No. | Treatments | No.of Monopodia/ plant (Mat.) | No.of Sympodia/ plant (Mat.) | No. of Balls/plant | Ball Girth(cm) | RGR* (gm$^{-2}$ day$^{-1}$) | SGR* (gm$^{-2}$ day$^{-1}$) | LGR* (gm$^{-2}$ day$^{-1}$) | OBGR* (gm$^{-2}$ day$^{-1}$) | CGR* (gm$^{-2}$ day$^{-1}$) | Partitioning percentage(%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $T_1$ | 80 kg N ha$^{-1}$ through urea | 2.950 | 22.13 | 43.20 | 7.95 | 0.152 | 3.28 | -0.838 | 4.33 | 6.92 | 63.01 |
| $T_2$ | 1/10 (8 kg N ha$^{-1}$) RDN through nano fertilizer | 2.413 | 17.70 | 35.41 | 7.36 | 0.122 | 2.90 | -0.673 | 3.12 | 5.46 | 57.59 |
| $T_3$ | 1/5 (16 kg N ha$^{-1}$) RDN through nano fertilizer | 2.490 | 19.14 | 37.16 | 7.55 | 0.133 | 2.97 | -0.740 | 3.46 | 5.82 | 59.63 |
| $T_4$ | 1/2.5 (32 kg N ha$^{-1}$) RDN through nano fertilizer | 2.825 | 21.48 | 42.31 | 7.76 | 0.148 | 3.20 | -0.814 | 4.24 | 6.78 | 63.33 |
| $T_5$ | Backbone polymer fragment liquid only as $T_2$ | 2.238 | 16.38 | 31.83 | 7.20 | 0.110 | 2.48 | -0.597 | 2.65 | 4.65 | 57.69 |
| $T_6$ | 80 kg N ha$^{-1}$+ 10 tonne compost ha$^{-1}$ + 500 kg castor cake ha$^{-1}$ | 3.038 | 22.99 | 44.85 | 8.12 | 0.157 | 3.40 | -0.872 | 4.46 | 7.15 | 62.70 |
| S. Em.± | | 0.089 | 0.67 | 1.28 | 0.093 | 0.004 | 0.10 | 0.025 | 0.14 | 0.21 | 1.80 |
| C.D. at 5% | | 0.253 | 1.91 | 3.62 | 0.263 | 0.013 | 0.29 | 0.072 | 0.39 | 0.60 | NS |
| C.V.% | | 13.45 | 13.50 | 13.09 | 4.86 | 12.90 | 13.35 | -13.50 | 14.93 | 13.9 | 11.87 |

** RGR: Root growth rate, SGR: Stem growth rate, LGR: Leaf growth rate, OBGR: Open ballgrowth rate, CGR: Crop growth rate*

Cotton seeds of *cv.*Bt. Cot. Hybrid-8BG II was sown at 120 cm row to row and 45 cm plant to plant distance. The crop was fertilized with above treatment. All other recommended agricultural practices were followed throughout crop period. Growth and yield attributers were recorded at the time to time.

## Results and Discussion

### Effect of nano fertilizer with INM on yield

The results [Table-1] indicated that effect of different treatments on seed cotton and stalk yield of Bt. cotton were significant during the period of 2017 to 2020 and also in pooled. On the basis of pooled mean, significantly higher seed cotton (2752 kg ha$^{-1}$) and stalk yield (4647 kg ha$^{-1}$) was recorded in treatment $T_6$ (80 N kg ha$^{-1}$+ 10 tonne ha$^{-1}$ compost + 500 kg ha$^{-1}$ + castor cake) and it was statistically at par with treatments $T_1$ (80 N kg ha$^{-1}$ through urea) and $T_4$ (1/2.5 32 kg N ha$^{-1}$ RDN through nano fertilizer). Hence, combined use of organic with inorganic fertilizers has considerable importance as to take remedial measures in fertility management and boosting the production. Similar results were found by various researchers, demonstrated the positive outcomes of integrated nutrient management in many areas [10-12].

### Effect of nano fertilizer with INM on growth and yield attributes parameters

The pooled results [Table-2] revealed that the effects of different treatments on number of monopodia, sympodia, balls per plant, ball girth, rootgrowth rate, stem growth rate, leafgrowth rate, open ball growth rate, crop growth rateat maturity and partitioning percentage were found significant. Significantly higher number of monopodia (3.04), sympodia (22.99), balls per plant (44.85), ball girth (8.12 cm), root growth rate (0.16 gm$^{-2}$ day$^{-1}$), stem growth rate(3.40gm$^{-2}$ day$^{-1}$), open ball growth rate(4.46gm$^{-2}$ day$^{-1}$) and crop growth rate(7.15gm$^{-2}$ day$^{-1}$) at maturity were obtained with INM treatment $T_6$ (80 N kg ha$^{-1}$ + 10 tonne ha$^{-1}$ compost + 500 kg ha$^{-1}$ castor cake), which was remain statistically at par with treatments $T_1$ (80 N kg ha$^{-1}$ through urea) and $T_4$ (1/2.5 (32 kg N ha$^{-1}$ RDN through nano fertilizer) at maturity except treatment $T_4$ in ball girth. While in case of leaf growth rate significantly lowest in treatment $T_5$ (Backbone polymer fragment liquid) and partitioning percentage significantly highest under treatment of $T_4$(1/2.5 (32 kg N ha$^{-1}$) RDN through nano fertilizer).These happen due to application of compost and castor cake with inorganic fertilizer to crop got nutrients and moisture for longer period of time and A progressive increase in sympodial branches with the subsequent addition in the nitrogen application rates was also reported by [13, 14] and availability of nutrients from organic sources and favorable conditions created in uptake of plant nutrients by the crop [15]. The plant development is the main purpose of photosynthetic activity of the plants and translocation of photosynthates within the plant which ultimately depend on their capacity to utilize available nutrients. Later boost of nitrogen which might have helped in higher chlorophyll formation and ultimately higher photosynthesis, resulted in more plant height and other growth parameter. Nitrogen is also known to contribute to cell elongation. These results are in conformity with results obtained by [16] and [16].

### Economics

The economics of different treatments was worked out on the basis of pooled mean and presented in [Table-2]. The data indicated that the maximum net realization of Rs. 109147 ha$^{-1}$ was recorded under application of 80 N kg ha$^{-1}$ through urea ($T_1$), followed by Rs. 104025 ha$^{-1}$ under application of 80 N kg ha$^{-1}$ + 10 tonne ha$^{-1}$ compost + 500 kg ha$^{-1}$ + castor cake ($T_6$) and $T_4$ (1/2.5 32 kg N ha$^{-1}$ RDN through nano fertilizer).

### Conclusion

In conclusion under North Saurashtra Agro Climatic Zone (AES-IV) application of 80 kg N ha$^{-1}$ + 10 tonne compost ha$^{-1}$ + 500 kg castor cake ha$^{-1}$ ($T_6$) followed by 80 kg N ha$^{-1}$ through urea ($T_1$) and 1/2.5 (32 kg N ha$^{-1}$) RDN through nano fertilizer ($T_4$) in addition of 40 kg $P_2O_5$ ha$^{-1}$ was found superior for getting higher yield of seed cotton under rainfed conditions. Whereas, 60 % RDN (48 kg ha$^{-1}$) was save under 1/2.5 (32 kg N ha$^{-1}$) RDN through nano fertilizer as compare to 80 kg N ha$^{-1}$ through urea (RDN), but not found economical.

**Application of research:** Study of nano-fertilizer with integrated nutrient management in Bt. cotton

**Research Category:** Nano-fertilizer

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**Study area / Sample Collection:** Main Dry Farming Research Station, Targhadia, 360023

**Cultivar / Variety / Breed name:** Bt. cotton (*Gossypium hirsutum* L.)

**Conflict of Interest:** None declared

**Ethical approval:** This article does not contain any studies with human participants or animals performed by any of the authors.
Ethical Committee Approval Number: Nil

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