

# GROWTH AND YIELD OF TEA (*Camellia sinensis*) AS INFLUENCED BY NANO UREA DURING PRE AND POST PRUNING OPERATION

## ABSTRACT

The growth and yield parameters of tea on mature plants of TV 23 clone were studied after application of Nano-urea as foliar spray at Experimental Garden for Plantation Crops, Assam Agricultural University, Jorhat during the period 2021-22.

Bud breaking number and time attain to tipping height were two growth parameters observed after pruning operation was carried out. Numbers of bud break was counted 30 days, 40 days and 50 days after pruning respectively. After 50 days maximum bud breaking number (106/ plant) was observed in 0.5% Nano-urea applied plot. To attain that height, lesser time was required (51 days) by the same plot. Plucking density, fine leaf count and green leaf yield were three yield parameters observed during first, second and rain flush. Plucking point density was found maximum (50 no/m<sup>2</sup>) during rain flush where 0.4% Nano-urea applied in 3 sprays. Fine leaf count was found maximum during first flush than it decreasing during second flush and rain flush respectively. The green leaf yield was found high in the plot where 0.4% Nano-urea applied in 3 sprays during rain flush.

*Keywords:* urea, tea, pruning, bud breaking, growth, tipping height, fine leaf count, plucking point density, green leaf yield.

## 1. INTRODUCTION

Tea [*Camellia sinensis* (L.) O. Kuntze] is a potential commercial crop cultivated across the world. It is an economic beverage famous for its health benefits and aroma ([Gebrewold, 2018](#)) India produces all types of tea but it is the world's largest producer and consumer of black tea.

The harvesting portion of tea is young pluckable shoots consisted with leaves, leaf buds and internodes collected from tea plant every after 7 (seven) days. So, unlike most other crops, it needs more nitrogen ([Han et al., 2008](#)) to get more vegetative growth. In tea plantations, nitrogen fertilization is a crucial field management technique. The availability of nitrogen fertilizer is essential for the development and quality of tea plants ([Ma et al., 2021](#)).

In order to feed and support the bulk of the world's population, fertilizers are fundamental to contemporary civilization. The formation of amino acids and proteins depends on nitrogen, which is one of the three main macronutrients required for agriculture along with phosphorus and potassium. Due to this, urea, ammonium salts, and organic fertilizers including manures, composts, and digestates are the most common forms of nitrogen fertilizer produced and used globally. ([Walling et al., 2022](#))

Increased crop yields and improved soil health can be attained through innovative and sustainable agriculture practices. Among these cutting-edge technologies, nanotechnology is one that is proven effective in agriculture. Nanotechnology has a greater nutrient uptake efficiency, and it will soon transform the methods used for foliar application ([Mohan et al., 2022](#)).

In the agricultural sector, the use of foliar spray of engineered nanoparticles as nano-fertilizers, nano-pesticides, nano-sensors, and nanocarriers is growing. Nano particles applied by foliar spraying increase the efficiency of plant protection technologies compared to traditional soil-root treatment. Foliar-sprayed nano particles mostly enter the leaves through stomata and travel to various plant sections via apoplastic and symplastic routes. ([Hong et al., 2021](#))

To address the nitrogen needs of crops, particularly during crucial growth phases, Indian Farmers' Fertilizer Cooperative Limited (IFFCO) created liquid nano urea as an alternative to urea. It is used as a foliar spray, aids in effective nitrogen absorption and penetration into the leaves, reaches plant sections where nitrogen is needed, and releases nutrients in a regulated manner, limiting loss to the environment. Additionally, it strengthens crop physiological features, particularly under drought-stressed environments. Since nano urea has a large surface area, is more soluble, and is smaller

than conventional urea, it may aid in a variety of metabolic pathways, enhancing yields and quality metrics while reducing fertiliser waste. (Lakshman *et al.*, 2022)

By applying liquid nano urea precisely and strategically to leaves, or "nano nitrogen," one can minimise urea losses, improve nutrient absorption effectiveness, and solve environmental problems including soil, air, and water pollution. It improves crop yield while requiring less nitrogen to be applied per unit area, improving agricultural economics. (Kumar *et al.*, 2021)

## 2. MATERIALS AND METHOD

Mature plants of TV 23 clone with spacing 105cmx60cm was used regarding the experiment. TV 23 was a cambod type yield clone developed by Tocklai Tea Research Institute. The experiment was done by using recommended dose of N, P<sub>2</sub>O<sub>5</sub> & K<sub>2</sub>O to the control plot. Other treatment plot was treated with different dose of nano urea (NU) instead of urea to fulfill the nitrogen requirement of the plant and recommended dose of P<sub>2</sub>O<sub>5</sub> & K<sub>2</sub>O. At an interval of 7<sup>th</sup> and 10<sup>th</sup> week after pruning number of bud break has been recorded from that of the pruned branches after pruning and was outlined in mean number of buds at various intervals. The time requirement to the buds to attain tipping height (25 cm from the pruning table) from the pruned sticks was recorded weekly basis. After the bud breaking, five plants from each plot were taken and randomly five buds per plants was tagged and recorded the length of the bud in centimeter. The recorded data was expressed in days from the day of pruning.

A grid of 50 cm<sup>2</sup>x50 cm<sup>2</sup> area divided into 10 cm<sup>2</sup> was placed on the top of the bush. Number of pluckable shoots and already plucked shoots were counted and converted them into number per 100 cm<sup>2</sup> per bush. This method was similar to the method described by Barua and Dutta in the year 1971 Plucking point density

$$= \frac{\text{No. of plucking point of the whole year}}{\text{tea bush spread (cm}^2\text{)}} \times 100$$

Green leaves were plucked regularly generally in weekly basis. The weight of green leaves recorded during the experimental period. The recorded data was expressed in kg per hectore. A bulked of green leaves was collected and weighted. separate the all one leaf and a bud, two leaf and a bud and soft *banji*. Weight them against the total and expressed in percentage. (The planters' Handbook by TRA, 1996).

The Randomized Block Design was used to statistically examine each piece of data (RBD). Calculating the corresponding "F" values allowed us to determine the significance of the variance resulting from the treatment effect (Panse and Sukhatme, 1985).

## 3. RESULTS AND DISCUSSION

The results of the present experiment on impact of Nano Urea influenced on growth parameters of mature tea plants conducted in the Experimental Garden for Plantation Crop, AAU, Jorhat, were presented below. Both field and laboratory studies were carried out to conduct the experiment. Field studies were conducted to study the growth characters and yield parameters. Laboratory studies were carried out to observe the biochemical parameters and nutrient availability of treated tea leaves. The experiment was conducted for the period of October 2021 to July, 2022.

In order to determine the difference between the tea plants impacted by the effluent and those unaffected by it for the previously mentioned parameters, the data was statistically analysed. The mean values were tabulated, and the associated CD values at the 5 percent probability level were computed and displayed in tables.

The experimental findings are furnished in this chapter under the following broad heads:

### 3.1 Effect of Nano Urea on growth parameters of mature tea

The growth parameters studied after light pruned were classified into two categories viz, number of bud break and days required to attain the tipping height. Growth parameters were observed after the pruning was done to all the treatment plot and was recorded.

#### 3.1.1 Bud breaking number

First application of all the treatments were done in the last week of November, 2022. Light prune was given to the treatments after 15 days from the first spray. Bud breaking was observed 30 days after the first spray *i.e.*, from mid of January, 2022. Data of bud breaking number influenced by various treatments of Nano Urea are presented in the Table 1. In the experiment the maximum value for number of bud break amongst the treatment was observed in treatment T<sub>7</sub> after 50 days from light

Comment [A1]: hectare

prune. But the data on the number of bud break shows no significant difference over control after one application of Nano Urea under various doses.

**Table 1. Numbers of bud breaking as affected by various Nano Urea treatments**

Treatment	30 days after pruning	40 days after pruning	50 days after pruning
T <sub>0</sub>	19.00	81.33	98.67
T <sub>1</sub>	21.67	84.00	101.33
T <sub>2</sub>	20.67	83.00	100.33
T <sub>3</sub>	22.33	84.66	102.00
T <sub>4</sub>	26.00	88.33	105.67
T <sub>5</sub>	24.67	87.00	104.33
T <sub>6</sub>	22.00	22.00	84.33
T <sub>7</sub>	24.33	24.33	86.66
T <sub>8</sub>	19.33	19.33	81.66

### 3.1.2 Time required to attain tipping height

The data of number of days required to attain tipping height after pruning influenced by application of various treatments of Nano Urea are presented in the Table 2. The results showed significant difference on time required to attain the tipping height amongst the treatments. It was observed that application of 0.5% Nano Urea took least time to attain tipping height *i.e.*, in treatment T<sub>4</sub> and treatment T<sub>8</sub> (51.33 and 51.67 days respectively) which is *at par* with application of 0.4% Nano Urea in treatment T<sub>3</sub> and treatment T<sub>7</sub> (52 days for both plots). The maximum days required to attain tipping height was observed in control plot *i.e.*, treatment T<sub>0</sub> (58 days).

The study revealed that with the increasing doses of Nano Urea, number of days required to attain tipping height was decreasing as it took lesser time to unfold buds. Similar findings were reported by Barman *et al.* (1999) in tea crop. Nano Urea improves the metabolic activity of the plant which enhanced the meristematic growth of the plant. ([Lakshman et al.,2022](#))

**Table2. Days required to attain tipping height due to various treatment of Nano Urea**

Treatment	Mean number of days
T <sub>0</sub>	58.00
T <sub>1</sub>	54.67
T <sub>2</sub>	53.67
T <sub>3</sub>	52.00
T <sub>4</sub>	51.33
T <sub>5</sub>	55.67
T <sub>6</sub>	54.00
T <sub>7</sub>	52.00
T <sub>8</sub>	51.67

## 3.2 Yield parameters

### 3.2.1 Plucking density

The experimental findings on number of plucking point density/m<sup>2</sup> of tea plants in various treatments of Nano Urea are presented in Fig 1. After 1<sup>st</sup> application of Nano Urea there is no significance difference amongst the treatment. After 2<sup>nd</sup> and 3<sup>rd</sup> application, plucking point density showed significant difference over control. The highest plucking point density/ m<sup>2</sup> was observed in treatment T<sub>7</sub> (35 no/m<sup>2</sup>) (0.4% Nano Urea × 3 spray + basal dose of P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O as recommended) after second application of Nano Urea followed by treatments T<sub>8</sub> (31 no/m<sup>2</sup>) (Nano Urea 0.5% × 3spray with basal dose of P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O). Lowest rate of plucking point density was observed in treatment T<sub>0</sub> (20 no/m<sup>2</sup>).

Comment [A2]: significant

After 3<sup>rd</sup> application of Nano Urea, the highest plucking point density was observed in treatment T<sub>7</sub> (50 no/m<sup>2</sup>) (0.4% Nano Urea × 3 spray + basal dose of P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O as recommended) followed by treatments T<sub>4</sub> (44 no/m<sup>2</sup>) and T<sub>8</sub> (42 no/m<sup>2</sup>). (Nano Urea 0.5% × 2 spray and 0.5% × 3 spray respectively with basal dose of P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O). Lowest rate of plucking point density was observed in treatment T<sub>0</sub> (34 no/m<sup>2</sup>).

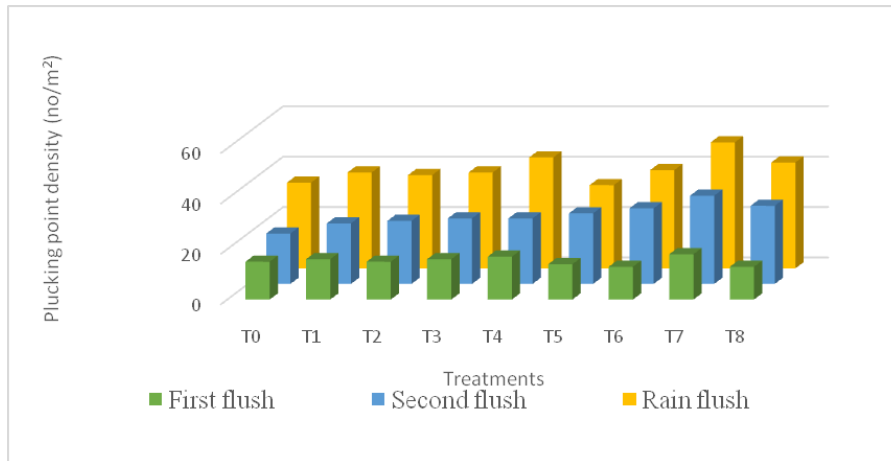


Fig.1.Plucking point density (no/m<sup>2</sup>) after 1<sup>st</sup>, 2<sup>nd</sup> and rain flush after application of Nano Urea.

### 3.2.2 Fine leaf count

The percentage of fine leaf during plucking after application of Nano Urea are presented in the Fig 2 below. No significant difference was observed in fine leaf percentage after 1<sup>st</sup> application of Nano Urea amongst the treatments. But after 2<sup>nd</sup> and 3<sup>rd</sup> application of Nano Urea, it showed significance difference over control. The highest fine leaf percentage was observed in treatment T<sub>7</sub> (71.33%, treated with 0.4% Nano Urea × 3 spray + basal dose of P<sub>2</sub>O<sub>5</sub>& K<sub>2</sub>O as recommended) followed with treatments T<sub>8</sub>(69.33%) and T<sub>4</sub> (69%). (0.5% Nano Urea × 3 spray and 0.5% in × 2 spray respectively with basal dose of P<sub>2</sub>O<sub>5</sub>& K<sub>2</sub>O as recommended).

After 3<sup>rd</sup> application, the highest fine leaf percent was observed in T<sub>7</sub> (63.33% treated with 0.4% Nano Urea × 3 spray + basal dose of P<sub>2</sub>O<sub>5</sub>& K<sub>2</sub>O as recommended) which is *at par* with treatments T<sub>8</sub> (61.66%) and T<sub>4</sub> (59.66%) (Nano Urea was applied 0.5% Nano Urea × 3spray and 0.5% Nano Urea × 2 spray respectively with basal dose of P<sub>2</sub>O<sub>5</sub>& K<sub>2</sub>O).

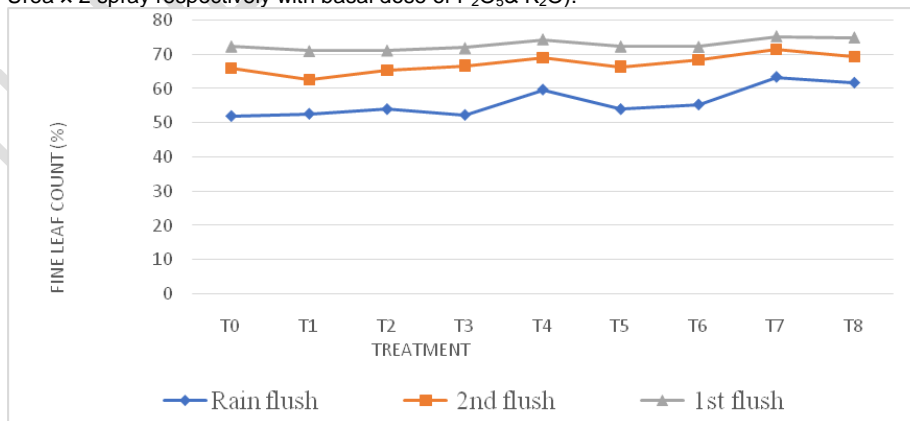


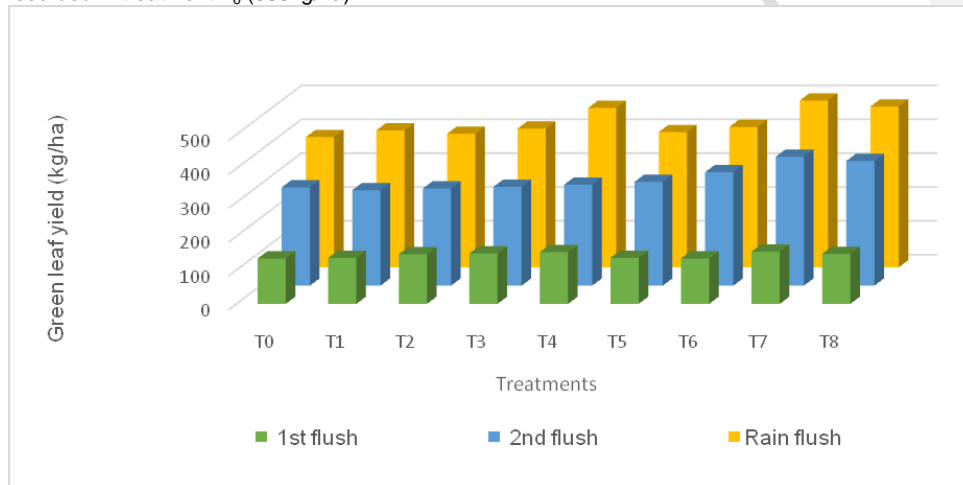
Fig.2. Fine leaf (%) after 1<sup>st</sup>, 2<sup>nd</sup> and rain flush after application of Nano Urea

### 3.2.3 Green leaf yield

Green leaf yield (kg/ha) of tea after application of Nano Urea in various treatments are presented in the Fig 3. After first application of Nano Urea, the highest green leaf yield was recorded in treatment T<sub>7</sub> (154.33 kg/ha) (0.4% Nano Urea × 3 spray + basal dose of P<sub>2</sub>O<sub>5</sub> & K<sub>2</sub>O as recommended). But there were no significant differences amongst the treatments after the 1<sup>st</sup> application of Nano Urea in green leaf yield of tea.

Both after second and third application, the green leaf yield showed statistical significance difference over the control. After second application of Nano Urea, the highest green leaf yield was found in treatment T<sub>7</sub> (380.67 kg/ha with 0.4% Nano Urea × 3 spray + basal dose of P<sub>2</sub>O<sub>5</sub> & K<sub>2</sub>O as recommended) which is *at par* with treatment T<sub>8</sub> (368 kg/ha) (Nano Urea was applied 0.5% Nano Urea × 3 spray with recommended dose of P<sub>2</sub>O<sub>5</sub> & K<sub>2</sub>O).

After third application of Nano Urea the highest green leaf yield was recorded in treatment T<sub>7</sub> (493 kg/ha with 0.4% Nano Urea × 3 spray + recommended dose of P<sub>2</sub>O<sub>5</sub> & K<sub>2</sub>O) and lowest yield was recorded in treatment T<sub>0</sub> (385kg/ha).



**Fig. 3. Green leaf yield (kg/ha) of tea after 1<sup>st</sup>, 2<sup>nd</sup> and 3<sup>rd</sup> application of Nano Urea**

Nitrogen application increases the vegetative growth of the plants. Harvested part of tea is leaves *i.e.*, vegetative part so the yield of tea is increased with increasing dose of nitrogen. [Majid et al. \(2017\)](#) observed yield traits and yield of maize increased with increasing dose of nitrogen level. [Raiguru et al. \(2020\)](#) observed that after application of urea nanohybrid, yield of tea increased.

#### 4. CONCLUSION

The application of Nano Urea, pruned branches can be brought earlier due to the faster growth of primaries. The yield and yield attributes show significant improvement at the application of Nano Urea 0.4%.

Higher application may adversely affect the quality of Nano Urea. Present investigation shows that recommended dose Nano Urea was economically beneficial than the conventional urea. The present findings shows that Nano Urea effect the growth and yield of tea. It increased both growth and yield as compared to conventional urea. Nano Urea was applied through foliar application so, efficiency was more and it reduced losses to the environment. It was a slow releasing fertilizer also target specific, good for sustainable crop production and healthy environment.

## REFERENCES:

- Anon Toyomasa (2003). Effects of nitrogen fertilizer on the constituents of new shoots in tea cultivars 'Yabukita', 'Sayamakaori', 'Kanayamidori' and 'Meiryoku'. *ChagyoKenkyuHokoku (Tea Research Journal)*.**96**: 33-47.
- Bala, N.; Dey, A.; Das, S.; Basu, R. and Nandy, P. (2014). Effect of hydroxyapatite nanorod on chickpea (*Cicer arietinum*) plant growth and its possible use as nano fertilizer. *Iranian Journal of plant physiology*. **4** (3): 1061-1069.
- Barman, T. S.; Handique, A. C. and Saikia, J. K. (1999). Effect of nitrogen manuring on growth rate of tea shoots. *Two and a Bud*.**46** (1): 28-31.
- Baruah, D. (1990). Effect of long-term application of nitrogen fertilization on yield of tea. *Two and a bud*.**37**: 1-3.
- Below, F. E. (2001). Nitrogen metabolism and crop productivity. *Handbook of plant and crop physiology*.**18**: 384-406.
- Bharud, R. W.; Deshmukh, K. V.; Pinjari, M. B. and Patil, R. B. (1986). Effect of foliar application of chemicals/ fertilizers on the growth and yield attributes of summer groundnut. *Journal of Maharashtra Agricultural Universities (India)*. **11** (3): 324-325.
- Cechin, I. and Fumis, T. F. (2004). Effect of nitrogen supply on growth and photosynthesis of sunflower plants grown in the greenhouse. *Plant Science*.**166** (5): 1379-138.
- Chiang, Y. H. (1960) Foliar application of urea and manganese to tea bushes. *Journal of Agricultural Chemistry*.**9**: 19-25.
- Gebrewold, A. Z. (2008). Review on integrated nutrient management of tea (*Camellia sinensis* L.). *Cogent food & agriculture*. **4**: 1543536.
- Ghasemi, V. M.; Moghaddam, S. S.; Rahimi, A.; Pourakbar, L. and Djordjevic, J. P. (2020). Winter cultivation and nano fertilizers improve yield components and antioxidant traits of dragon's head (*Lallemantiaiberica*(M.B.) Fischer and Meyer). *Plants*. **9** (2): 252.
- Ghosh, S. K. and Bera, T. (2021). Molecular mechanism of nano fertilizer in plant growth and development: A recent account. *Advances in nano-fertilizer and nano-pesticides in agriculture*. **22**: 535-560.
- Han, W. Y.; Man, L. F.; Shi, Y. Z.; Ruan, J. Y. and Kemmitt, S. (2008). Nitrogen release dynamics and transformation of slow-release fertiliser products and their effects on tea yield and quality. *Journal of the Science of food and agriculture*.**88** (5): 839-846.
- Harper, J. E. (1994). Nitrogen metabolism. *Physiology and determination of crop yield*.**11**(A): 285-302.
- Hchami, S. H. J. and Alrawi, T. K. (2020). Nano fertilizer, benefits and effects on fruit trees: A review. *Plant archives*. **20** (1): 1085-1088.
- Hong, J.; Wang, C.; Wagner, D. C.; Torresdey, J. L. G. and Rico, C. M. (2021). Foliar application of nanoparticles: mechanisms of absorption transfer and multiple impacts. *Environmental Science: Nano*. **8** (5): 1196-1210.
- Hoshina, T.; Kozai, S. and Ishigaki, K. (1978). Foliar absorption of <sup>15</sup>N labelled urea by tea plant. *Chagyogijutsukenkyu (Study of tea)*. **54**: 33-36.
- <https://www.iffco.in>
- Huang, W.; Lin, M.; Liao, J.; Li, A.; Tsewang, W.; Chen, X. and Sun, B. (2022). Effect of potassium deficiency on the growth of tea (*Camellia sinensis*) and strategies for optimizing potassium levels in soil: A critical review. *Horticulturae*. **8** (7): 660.
- Jat, G. and Kacha, H. (2014). Response of Guava to foliar application of urea and zinc on fruit set, yield and quality. *Journal of Agri Search*. **1** (2): 86-91.
- Jayaraman, V. (1962). Fertilizer use in tea in South India. *Fertil news*.**7**(8): 7-17.

- Juthery, H. W. A.; Habeeb, K. H.; Altaee, F. J. K.; Taey, D. K. A. and Tawaha, A. R. M. (2018). Effect of foliar application of different sources of nano-fertilizers on growth and yield of wheat. *Journal of innovative scientific information and services network*. **15** (4): 3988-3997.
- Khan, M. R. and Rizvi, T. F. (2017) Application of nano fertilizer and nano pesticides for improvements in crop production and protection. *Nanoscience and plant soil systems*. **48**: 405-427.
- Khan, P.; Memon, M. Y.; Imtiaz, M. and Aslam, M. (2009). Response of wheat to foliar and soil application of urea at different growth stages. *Pak. J. Bot.* **41**(3): 1197-1204.
- Lakshman, K.; Chandrakala, M.; Prasad, P. N. S.; Babu, G. P.; Srinivas, T.; Naik, N. R. and Korah, A. (2022). Liquid Nano-Urea: An Emerging Nano Fertilizer Substitute for Conventional Urea. *Chronicle of Bioresource Management*. **6** (2): 54-59.
- Leghari, S. J.; Wahocho, N. A.; Laghari, G. M.; Laghari, A. H.; Bhabhan, G. M.; Talpur, K. H.; Bhutto, T. A.; Wahocho, S. A. and Lashari, A. A. (2016). Role of nitrogen for plant growth and development. A Review. *Advances in Environmental Biology*. **10** (9): 209-218.
- Liu, M. Y.; Tang, D.; Shi, Y.; Ma, L.; Zhang, Q. and Ruan, J. (2021) Foliar N application on tea plant at its dormancy stage increase the N concentration of mature leaves and improves the quality and yield of spring tea. *Frontiers in plant science*. **12**: 753086.
- Ma, L.; Yang, X.; Shi, Y.; Yi, X.; Ji, L. and Ni, Y. C. K. (2021). Response of tea yield, quality and soil bacterial characteristics to long term nitrogen fertilization in an eleven-year field experiment. *Applied soil ecology*. **166**: 103976.
- Mahil, E. I. T. and Kumar, B. N. A. (2019). Foliar application of nano fertilizers in agricultural crops- A review. *Journal of farm science*. **32** (3): 239-249.
- Majid, M. A.; Islam, M. S.; Sabagh, A. E.; Hasan, M. K.; Saddam, M.O.; Barutcular, C.; Ratnasekera, D.; Abdelaal, A. A. and Islam, M. S. (2017). Influence of varying nitrogen levels on growth, yield and nitrogen use efficiency of hybrid maize (*Zea mays*). *Journal of Experimental Biology and Agricultural Sciences*. **5** (2): 134-142.
- Merghany, M.; Shahein, M. M.; Sliem, M. A.; Abdelgawad, K. F. and Radwan, A. F. (2019) Effect of nano fertilizer on cucumber plant growth, fruit yield and it's quality. *Plant archives*. **19** (2): 165-172.
- Mohan, S. S.; Venkat, R. and Ajay, A. (2022). Applications of Nano Fertilizers in Indian Agriculture. *Agriculture & food e-newsletter*. **4** (5): 341-343.
- Mohanraj, J.; Subramanian, A. and Lakshman. (2019). Role of nano fertilizer on greenhouse gas emission in rice soil ecosystem. *Madras agricultural journal*. **106**: 657-663.
- Mollah, M. A. F.; Khan, M. A.; Tareq, M. Z.; Rafiq, Z. A. and Mozammel, M. (2019). Effect of foliar fertilization on growth and yield of Jute. *Bangladesh J. Environ. Sci*. **36**: 11-14.
- Mondal, A. B. and Mamun, A. A. (2011). Effect of foliar application of urea on the growth and yield of tomato. *Frontiers of Agriculture in China*. **5** (3): 372-374.
- Mondal, M. M. A.; Puteh, A. B.; Malek, M. A. and Roy, S. (2012). Effect of foliar application of urea on physiological characters and yield of soyabean. *Legume Research. An International Journal*. **35** (3): 202-206.
- Mondal, M. M. A.; Rahman, M. A.; Akter, M. B. and Fakir, M. S. A. (2011). Effect of foliar application of nitrogen and micronutrients on growth and yield in mungbean. *Legume Research: An International Journal*. **34** (3): 166-171.
- Prasad, H.; Prasad, D.; Bhan, C.; Bairwa, S. K. and Babu, S. (2013). Effect of foliar application of urea, zinc sulphate, and 2, 4-D on kinnow mandarin: A review. *Journal of Progressive Agriculture*. **4** (1): 148-153.
- Raguraj, S.; Wijayathunga, W. M. S.; Gunaratne, G. P.; Amali, R. K. A.; Priyadarshna, G.; Sandaruwan, C. and Karunaratne, G. (2020). Urea- hydroxyapatite nanohybride as an efficient nutrient source in *Camellia sinensis* (L.) Kuntze (tea). *Journal of plant nutrition*. **43** (15): 2383-2394.

- Rathnayaka, R. M. N. N.; Mahendran, S.; Iqbal, Y. B. and Rifnas, L. M. (2018). Influence of urea and nano nitrogen fertilizers on the growth and yield of rice (*Oryza sativa* L.) cultivar 'Bg 250'. *International journal of research publications*.**5** (2): 7-7.
- Walling, E. and Vaneeckhaute, C. (2022). Nitrogen fertilizers and the environment. Publisher: CRC PRESS Taylor and Francis.
- Yang, X.; Ma, L.; Shi, Y.; Yi, X.; Ji, L.; Cheng, Y.; Ni, K. and Ruan, J. (2021). Response of tea yield, quality and soil bacterial characteristics to long-term nitrogen fertilization in an eleven-year field experiment. *Applied Soil Ecology*. **166**: 103976.
- Zatylny, A. M. and Pierre, R. G. (2006). Nitrogen uptake, leaf nitrogen concentration, and growth of saskatoons in response to soil nitrogen fertility. *Journal of plant nutrition*.**29** (2): 209-218.
- Zulfiquar, F.; Navarro, M.; Ashraf, M.; Akram, N. A. and Bosch, S. M. (2019). Nano fertilizer use for sustainable agriculture: Advantages and limitation. *Plant science*.**289**: 1102070.

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