Journal of Scientific Research and Reports

Volume 30, Issue 9, Page 131-137, 2024; Article no.JSRR.122019
ISSN: 2320-0227

Effect of Nano Urea on Leaf Nutrients and Some Quality Parameters of Tea (*Camellia sinensis* (L) O. Kuntze)

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: https://doi.org/10.9734/jsrr/2024/v30i92337

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/122019

Original Research Article

Received: 18/06/2024
Accepted: 20/08/2024
Published: 26/08/2024

ABSTRACT

Some important 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 2021-2022. The usage of "Nano Urea" (Liquid), a novel product created and patented by Indian Farmers Fertilizer Cooperative Limited (IFFCO), is projected to replace the use of urea granules, one of the most widely used fertilizers in the world.

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Cite as: *Saikia, Plabita, Aditi Smith Gogoi, Rana Pratap Bhuyan, Nawab Tayab Rafique, and Manuranjan Gogoi. 2024. "Effect of Nano Urea on Leaf Nutrients and Some Quality Parameters of Tea (Camellia Sinensis (L) O. Kuntze)". Journal of Scientific Research and Reports 30 (9):131-37. https://doi.org/10.9734/jsrr/2024/v30i92337.*

Leaf nutrients i.e., nitrogen, phosphorus, potassium and quality parameters i.e., Caffeine, polyphenol were observed after application of nano urea. Leaf nitrogen, leaf phosphorus and leaf potassium were found to be increased with the application of higher dose of Nano Urea. Leaf nitrogen was observed maximum (4.57%) in the plot where 0.4% Nano-urea applied in three sprays. Total phosphorus content of leaf was found to be the highest in treatment T_7(0.423%) the lowest was observed in treatment T_0 (0.370%). Total potassium content of leaf was the highest in treatment T_7 (2.517%) and lowest K_2O content was observed in treatment T_0 (2.013%) which was a control.

In quality parameters, it was found that application of Nano Urea showed significant impact on the total caffeine content of tea leaf. The highest value of caffeine was found in treatment T_7 (3.233%) and lowest was found in treatment T_0 (3.10%) (control).

Keywords: Nano-urea; tea; caffeine; polyphenol; leaf N, P, K.

1. INTRODUCTION

India is the world's largest producer and consumer of all tea varieties, specially the production of black tea. Tea [*Camellia sinensis* (L.) O. kuntze] is a commercially cultivated plantation crop across the world. It is an economic beverage also famous due to its flavour and aroma [1].

Nitrogen is important for plant development, chlorophyll production, and the photosynthetic process that turns sunlight into food for plants. Without sufficient nitrogen, plants may experience stunted growth and lower output. Because it is an essential component of chlorophyll, which converts the energy from sunlight and carbon dioxide into sugar molecules, nitrogen is extremely important.

In order to increase the production of chlorophyll and consequently the yield of tea, long-term nitrogen treatment increased the expression of critical genes for this process. Additionally, it greatly reduced the catechin level while increasing the total free amino acid content, or theanine, in fresh tea leaves, which is helpful for maintaining the freshness of the tea beverage. Long-term nitrogen administration resulted in a considerable decrease in the levels of nerolidol and indole in withered leaves as well as benzyl alcohol and 2-phenylethanol in fresh tea leaves, both of which were unfavourable to the development of aroma compounds with floral and fruity undertones. Generally, a balanced fertiliser nitrogen level balanced tea output and quality. In this way nitrogen application impacts tea quality [2].

Indian Farmers' Fertilizer Cooperative Limited (IFFCO) developed liquid nano urea as an alternative to urea to satisfy the nitrogen demands of crops, particularly during critical growth periods. It is applied as a foliar spray, helps the leaves absorb nitrogen effectively, penetrates to the parts of the plant that need nitrogen, and releases nutrients in a controlled way, reducing loss into the environment. Additionally, it increases crop physiological characteristics, especially in conditions with drought stress. Lakshman et.al. in [3] in his work found that Nano urea may help in a number of metabolic processes, improving yields and quality metrics while decreasing fertiliser waste since it has a larger surface area, is more soluble, and is smaller than regular urea.

Considering the various aspects of nano urea in agriculture, a research work had been carried out to study the leaf nutrient and quality parameters of tea (*Camellia sinensis*) as influenced by application of nano urea.

2. MATERIALS AND METHODS

2.1 Study Area and Climate

An attempt has been made to study the effect of application of Nano urea in mature tea plants in the Experimental Garden for Plantation Crops, Department of Tea Husbandry &Technology, Assam Agricultural University, Jorhat on leaf nutrient content, polyphenol content and caffeine content in plucked tea shoots.

Jorhat, Assam has a subtropical humid climate, and the monsoon season typically lasts from April until September. During the experimental period (November 2021 to July 2022) the observations of various weather parameters recorded at the meteorological observatory of the Department of Agricultural Meteorology, Assam Agricultural University, Jorhat. During the period of research works the maximum temperature ranges from 23.3°C to 33.5°C and minimum

temperature ranges from 9.6°C to 25°C. The relative humidity ranges from 93 to 99% during morning hours and 49 to 80% during evening hours. Total 1559.6 mm rainfall was received during the period with maximum rainfall of 321.8 cm in June, 2022 and minimum rainfall of 0.6 cm in December, 2021.

2.2 Treatment Detail

Planting material taken for the experiment was TV 23 which is a yield clone. There are a total of 27 plots with 9 treatments having 3 replications for each treatment. To satisfy the plant's need for nitrogen and the recommended dose of P_2O_5& K_2O, treatment plot was treated with different doses of nano urea (NU) rather than urea as mentioned below-

T_0 - Recommended dose of N, P_2O_5 & K_2O
T_1- 0.2% NU × 2 sprays + recommended dose of P_2O_5 & K_2O
T_2-0.3% NU × 2 sprays + recommended dose of P_2O_5 & K_2O
T_3- 0.4% NU × 2 sprays + recommended dose of P_2O_5 & K_2O
T_4- 0.5% NU × 2 sprays + recommended dose of P_2O_5 & K_2O
T_5- 0.2% NU × 3 sprays + recommended dose of P_2O_5 & K_2O
T_6- 0.3% NU × 3 sprays + recommended dose of P_2O_5 & K_2O
T_7- 0.4% NU × 3 sprays +recommended dose of P_2O_5 & K_2O
T_8– 0.5% NU × 3 sprays + recommended dose of P_2O_5 & K_2O

2.3 Polyphenol Estimation

Estimation of polyphenol was done following the method given by Bray and Thorpe, [4] using Folin-ciocalteu reagent. The absorbance was measured with a spectrophotometer at 650 nm. A standard curve was created using various gallic acid concentrations. Total polyphenol was expressed in percentage.

2.4 Caffein Estimation

The total caffeine in fresh tea leaves was calculated in percentage. By taking weight of crude caffeine and weight of fresh leaves in gram, the amount of caffeine was calculated.

2.5 Nitrogen Estimation

According to AOAC's description of the modified Kjeldahl method the calculated nitrogen was displayed as a percentage of the dried sample. The process entails the oxidative destruction of the plant matter using several digestion mixtures, the most popular of which is the nitro-perchloric digestion (di-acid) mixture. In order to produce a colourless solution, digestion must continue until the acid liquid has entirely volatilized. Following that, numerous elemental analyses are performed on the filtered solution using the proper methods.

2.6 P_2O_5 Estimation

To measure leaf P_2O_5, 5 ml of the filtered solution were placed in a 50 ml volumetric flask together with 10 ml of the nitric acid-molybdate-vanadate mixture. The volume was then filled, and the mixture was thoroughly mixed. In about 30 minutes, the colour has fully developed. On a spectrometer with a 450 mμ filter, measure the amount of yellow hue that has generated.

2.7 K_2O Estimation

To measure available K_2O put the solution straight into the atomizer of the flam photometer, the 100 of which has been set with 40 ppm K solution, and record the reading to find out how much leaf K_2O is there. Find the standard curve measurement that corresponds to the extract's K concentration. The concentration measurement allowed for the calculation of the K content of the plant sample.

2.8 Statistical Analysis

A statistical analysis of each piece of data (RBD) was performed using the Randomized Block Design. The significance of the variance resulting from the treatment effect might be ascertained by calculating the relevant "F" values [5].

3. RESULTS

The results of the experiment on impact of Nano Urea influenced on growth parameters of mature tea plants was conducted for the period of October 2021 to July, 2022in the Experimental Garden for Plantation Crop, AAU, Jorhat, were presented below. Nutrient availability and the biochemical parameters of treated tea leaves were studied in laboratory condition whereas field studies were conducted to study the phytotoxicity. The experimental 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.

3.1 Available Nutrients in Plucked Shoots (N, P, K)

Better vegetative growth is facilitated by nitrogen, and quick, precocious growth is facilitated by an adequate supply of nitrogen. Increases plant growth, gives plants a dark green hue, and enhances the flavour and juiciness of forage plants and leafy vegetables. encourages fruit bud growth, boosts fruit set, and enhances fruit quality.

The experimental data (Table 1) showed significant difference on leaf nitrogen (%), P_2O_5 (%) & K_2O (%) as influenced by application of Nano Urea. The height value of leaf nitrogen was found on treatment T_7 (4.57%) which was followed by treatments T_4 (4.53%) and T_8 (4.43%). The lowest leaf nitrogen was found in treatment T_0(3.90%) (control).

Total phosphorus content of leaf (Table 1) was found to be the highest in treatment T_7(0.423%) which was followed by treatment T_4 (0.410%). The lowest phosphorus content of tea leaves was observed in treatment T_0 (0.370%) (control).

Significant difference was observed in K_2O content of tea leaves as influenced by application of Nano Urea with different doses (Table 1). Total potassium content of leaf was the highest in treatment T_7 (2.517%) followed by treatments T_4 (2.503%) and T_6 (2.460%). Lowest K_2O content (2.013%) was observed in treatment T_0 which was a control.

3.2 Quality Parameters of Tea

Quality of tea is a very important parameter. The study revealed that some quality parameter like caffeine, polyphenol, leaf nitrogen, phosphorus and potassium gradually increased with increasing dose of Nano Urea.

The experimental data of total polyphenol (%) are presented in the Table 1 as influenced by various treatment of Nano Urea. The impact of Nano Urea on total polyphenol (%) on tea leaves was found to be non-significant. The highest value of total polyphenol was found in treatment T_7 (28%) (0.4% Nano Urea × 3 sprays + basal dose of P_2O_5 & K_2O as recommended). The lowest value of total polyphenol was found in treatment T_0 (22%).

Owuor et.al. in 1994 reported that black tea's caffeine concentration increased as nitrogen application rates were raised. In the experiment it was found that application of Nano Urea showed significant impact on the total caffeine content of tea leaf. The highest value of caffeine was found in treatment T_7 (3.233%) and lowest was found in treatment T_0 (3.10%) (control) (Table 2).

Table 1. Nitrogen, phosphorus and potassium percentage tea leaf under various treatments of nano urea

Treatment	Leaf nitrogen (%)	Leaf phosphorus (%)	Leaf potassium (%)
T_0	3.90	0.370	2.013
T_1	3.97	0.373	2.200
T_2	4.18	0.380	2.240
T_3	4.35	0.390	2.363
T_4	4.53	0.410	2.503
T_5	4.25	0.390	2.387
T_6	4.41	0.383	2.460
T_7	4.57	0.423	2.517
T_8	4.43	0.387	2.383

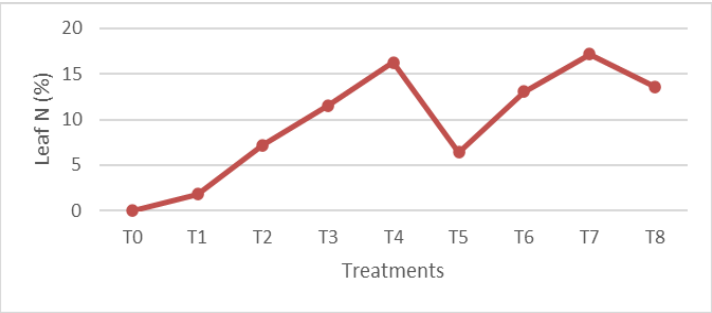

Fig. 1. Increasing percentage leaf nitrogen over control

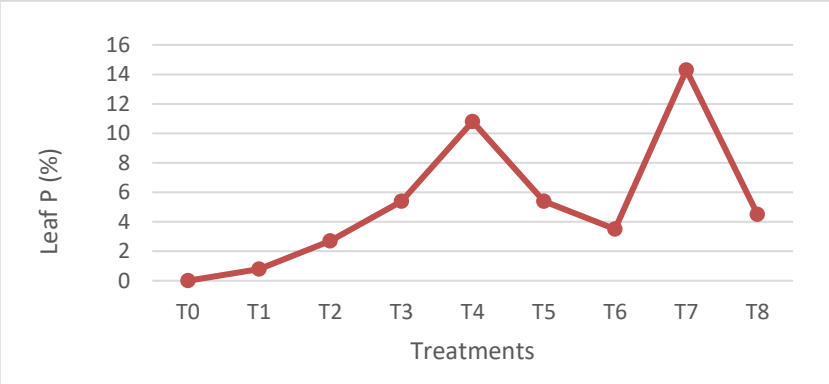

Fig. 2. Increasing percentage leaf phosphorus over control

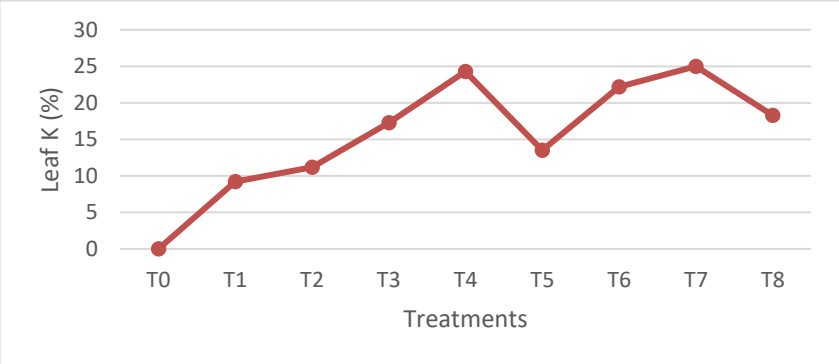

Fig. 3. Increasing percentage leaf potassium over control

Table 2. Total polyphenol and caffeine (%) of tea leaf under various treatments of nano urea

Treatment	Total polyphenol (%)	Total caffeine (%)
T_0	22.00	3.100
T_1	25.00	3.157
T_2	23.67	3.153
T_3	25.33	3.197
T_4	26.67	3.160
T_5	24.00	3.217
T_6	24.00	3.223
T_7	28.00	3.233
T_8	23.33	3.130

4. DISCUSSION

Leaf nitrogen content was found maximum in T_7 treatment, where 4% Nano Urea was applied in three sprays with recommended P_2O_5 and K_2O as basal dose. It is the maximum dose of Nano Urea as per recommendation. As after application of Nano Urea, unutilized nitrogen was stored in the vacuoles and easily distributed through phloem when the sink needs so the leaf nitrogen percentage was increased as it presents in the leaves in available form. So, due to that reason leaf nitrogen percentage might be increased. This result can be supported with the findings of Zatylny et al. [6]. They found that leaf nitrogen content of saskatoon crop had a corelation with nitrogen application. The percentage of leaf nitrogen increased linearly with increasing dose of nitrogen application in saskatoon plants. Raguraj et al. [7] applied a slow-release fertilizer urea-hydroxyapatite nanohybrids to tea plants (*Camellia sinensis*) in Sri Lanka. They found increasing rate of leaf nitrogen as compared to plots where conventional urea was used.

Leaf phosphorus percentage was found highest in treatment T_7 where total 4% Nano Urea was spray in 3 sprays with recommended basal dose of P_2O_5 & K_2O. Also leaf potassium percentage was found maximum in T_7 treatment. Nitrogen increases the uptake of phosphorus and requirement of potassium as potassium helps in nitrogen metabolism. According to Huang et al. [8] potassium is one of the essential elements for tea plant. It helps in growth and yield of tea. Potassium is directly corelated with the nitrogen element. During Nano Urea application leaf nitrogen was increased and due to that leaf potassium was also increased. In Sri Lanka, Ragurajet al. In 2020 found evidences of increased nitrogen content in tea leaf with the increased dose of application of nitrogen.

Grunes in [9] observed that nitrogen frequently increases the root growth of plant and foraging capacity of phosphorus. Top growth of plant simultaneously increases the absorption of phosphorus. Thummanatsakun and Yampracha in [10] recorded that with increasing dose of nitrogen fertilizer, potassium requirement of the plant is high in cassava plant. In the present research similar results were found i.e., the phosphorus content in tea leaf was increased with the higher doses of nano urea.

The current analysis demonstrates that Nano Urea at the prescribed dose was more cost-effective than traditional urea. Nano urea was applied by foliar application, which increased efficiency and decreased environmental losses. It was a fertilizer that released slowly and was targeted specifically for sustainable crop production. The nano urea is an environmentally friendly product because urea leaching is one of the major issues in crop fields that causes soil and water contamination. Agricultural economics are improved since it increases crop output while needing less nitrogen to be sprayed per unit area [11].

5. CONCLUSION

The application of Nano Urea, it was observed that leaf nitrogen, phosphorus and potassium content were increased with increasing dose. All the three parameters were found maximum in the plots where 0.4% Nano Urea was applied.

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. 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.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

ACKNOWLEDGEMENT

The authors thank the Assam Agricultural university and all the teachers of Department of Tea Husbandry and Technology for constant encouragement and support.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/122019