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# Influence of Urea and Nano-Nitrogen Fertilizers on the Growth and Yield of Rice (*Oryza sativa* L.) Cultivar 'Bg 250'

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**Abstract**

Nitrogen fertilizers play an important role in the cultivation of rice. Excessive and improper usage of Nitrogen fertilizer causes problems on human and environment. It is essential for a suitable alternative source of Nitrogen with reduced harm on environment. Nano nitrogen fertilizers are alternative to conventional fertilizers with slow and control release of nitrogen. An experiment was conducted at the Rice Research Station, Sammanthurai, Sri Lanka during the season of 'Yala 2017' April to July involving the use of NPK fertilizers and Nano-Nitrogen fertilizer to test the growth attributes and yield of rice cultivar 'Bg 250'. The experiment was laid out in the Randomized Complete Block Design with five treatments and four replications and experiment was conducted in plastic pots (25cm height and 40cm diameter). The seeds were wrapped with net cotton cloth and three days after germination, it was transferred to seedling tray. At 12th day uniform and healthy seedlings were transplanted in the plastic pots. A number of 10 seedlings were raised in each plastic pot. There were altogether 20 plastic pots. Five treatments viz; T1 – Control (No fertilizer), T2 – 100% recommended fertilizer (Urea, TSP and MOP), T3 – 75% Urea + 25% Nano- Nitrogen (Usual TSP and MOP) fertilizer, T4 – 50% Urea + 50% of Nano- Nitrogen (Usual TSP and MOP) fertilizer and T5 – 100% Nano-Nitrogen (Usual TSP and MOP) fertilizer were applied. The results revealed that there were significant ($p<0.05$) differences between treatments in the tested parameters. The application of 100% Nano-Nitrogen fertilizer has given the highest growth performance with regard to plant height

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(57.9cm), number of tillers per plant (6), plant dry weight during the ripening stage (9.9g). With regarding to yield (2.8tonnesha$^{-1}$) 100% Nano-Nitrogen fertilizer has given the highest performance. Treatment, where no any fertilizer applied, has given the lowest performance in the plant height, number of tillers per plant, plant dry weight and yield. Hence it could be indicated that Nano-Nitrogen could use as an alternative to urea in the cultivation of rice cultivar 'Bg 250' in the Sandy Regosol soil of Sammanthurai with reduced nitrogen pressure on the environment.



Keywords: Dry weight; Height; Nano-fertilizer; Rice; Tillers; Yield

## 1. Introduction

Rice (Oryza sativa L.) is the main staple food for over half the population worldwide. Fertilizers have a crucial role in enhancing food production and quality particularly when the introduction of high-yielding and fertilizer-responsive varieties. Majority of the crops grown such as rice need large quantities of inorganic inputs. Rice yield mostly relies on soil conditions and furthermore on the supply of the accessible nutrients like nitrogen, phosphorus, potassium, sulphur and zinc (Masum et al., 2013). Rice plants require large amounts of mineral nutrients including nitrogen for their growth, development, and grain production (Ma, 2004).

After carbon, hydrogen and oxygen, nitrogen (N) is one of the important elements in plants because of its key part in chlorophyll production, which is basic for the photosynthesis process. Also, nitrogen is part of different enzymatic proteins that catalyze and regulate plant-development processes (Sinfield et al., 2010). Besides, nitrogen contributes to the generation of chemical components that secure against parasites and plant diseases (Hoffland et al., 2000). At last, crop yield and biomass are profoundly affected by N fertilization (Tremblay et al., 2011). Plants absorb nitrogen as a mineral nutrient primarily from soil, and it can be may come in the form of ammonium (NH4+) and nitrate (NO3-) (Taiz and Zeiger, 2010). Nonetheless, soil N supply is often limited (Vigneau et al., 2011), which forces farmers to increase the amount of N fertilizers in order to accomplish better crop yield. However, farmers may provoke nitrogen overfertilization, which thwarts optimum plant productivity (Rubio-Covarrubias et al., 2009), as plants are not able to absorb the excess of N-fertilizer. This entails unnecessary expenditure on the part of farmers. Nitrate leaching, soil denitrification, and volatization are the main processes for N-fertilizer excess loss, contributing to environmental pollution (Zebarth et al., 2009) . Nitrate leaching contaminates groundwater and other bodies of water, which may contribute to eutrophization. In addition, volatized N contributes to global warming by releasing nitrous oxides (i.e., NO, $N_2O$), which are considered greenhouse gases. Furthermore, a reaction between ammonium ions near the soil's surface and alkaline rainwater generates gaseous ammonia, which disperses into the atmosphere (Timmer et al., 2005). When there is a high N supply in leafy vegetable crops, N mobile form concentrations (i.e., nitrate, ammonium) increase in leaves, thus becoming hazardous to human health. A high-nitrate diet is an important factor in the development of several human diseases such as methahemoglobinaemia, and gastric and bladder cancer (Parks et al., 2012).

Consequently, to achieve sustainable agriculture with more yield and maintaining the society ís health is the goal of researchers in agriculture. In such manner, utilization of chemical fertilizers has long been condemned because of their harmful impacts on the environment and quality of agricultural products, and researchers are looking for better alternatives. Studies have been conducted to boost rice production however exclusively two or three can be seen in the literature involving nano-materials. Nano-materials are defined as the materials with a single unit between one and a hundred nm in size in a minimum of one dimension (Liu and Lal, 2015). Nano-fertilizers and slowly released fertilizers are appropriate alternatives to conventional fertilizers for gradual and controlled supply of nutrients in the soil. Alternative nano-fertilizers such as nano chelate with chemical fertilizers reduce pollutions which is economical (Mousavi-Fazl and Faeznia, 2008). The development of efficient nitrogen management protocols requires recognizing cultivar differences and critical stages of crop growth that fertilization is necessary to avoid potential yield loss (Jiang et al., 2005). Managing rice crop's nitrogen nutrition is difficult because lowland rice crop culture leads to nitrogen losses through ammonia volatilization, nitrification, denitrification, leaching, and runoff (Johnson, 2006), which decreases the availability of nitrogen for rice plants. Therefore, this research aims to evaluate nitrogen nano-fertilizers' effect on a selected rice cultivar's growth and yield.

## 2. Materials and Methods

This experiment was conducted at the Rice Research Station, Sammanthurai, Sri Lanka During the 'Yala' 2017. The Agro Ecological Zone of the experimental area is DL 2b. The soil of the research area was sandy loam. The experiment was conducted using plastic pots and twenty plastic pots were used for this experiment. The height and the diameter of the pots were 30cm and 40cm respectively. A number of two holes were made at the bottom of each plastic pot. Pots were filled by soil taken from the Rice field of the Rice Research Station. The filling was done leaving 5cm from the top of the pot to ensure the stagnation of water during the experiment. The rice cultivar "Bg 250" was used for this study. Rice seeds were soaked in water for 24 hours and were then incubated for 48 hours by wrapping with a cotton cloth. The seed moisture was maintained by spraying with water over the wrapped cloth. After 48 hours of incubation when the rice seeds were sprouted, they were transferred to seedling tray. The seedling tray was prepared by puddled soil made by using sieved soil taken from the rice field of Research Station. After 12 days, the healthy and uniform seedlings were transplanted on already prepared plastic pots which were filled by soil taken from the Rice Research Station. A number of ten plants were managed in each plot. A total number of 200 rice plants were raised for the experimental purpose.

### 2.1. Treatment Structure

This experiment was laid out in the Randomized Complete Blocked Design (RCBD) with five treatments and four replications. A number of 20 pots were used for this study and each pot contained 10 rice seedlings.

T1 - No fertilizer (Control) (Urea - 0kgha-1, TSP - 0kgha-1, MOP - 0kgha-1, Nano-N - 0kgha-1)

T2 - 100% of usual fertilizer (Urea - 225kgha-1, TSP - 55kgha-1, MOP - 60kgha-1, Nano-N - 0kgha-1)

T3 - 75% Urea + 25% Nano-N fertilizer (Urea - 169 kgha-1, TSP - 55kgha-1, MOP 60kgha-1, Nano-N - 48kgha-1)

T4 - 50% Urea + 50% of Nano-N fertilizer (Urea - 113kgha-1, TSP - 55kgha-1, MOP 60kgha-1, Nano-N - 95kgha-1)

T5 - 100% Nano-N fertilizer (Urea - 0kgha-1, TSP - 55kgha-1, MOP 60kgha-1, Nano-N - 190kgha-1)

### 2.2. Plant height

A number of three plants were randomly selected from each replicate of the treatments. The heights of these plants were measured manually by using measuring scale. The height was measured in cm from the base of the main stem to the apex.

### 2.3. Number of tillers

A number of three plants were randomly selected from each replicate of the treatments during the optimum tillering stage. The total number of tillers per plant was counted and the data were recorded.

### 2.4. Plant dry weight

A number of three plants were selected during the ripening stage and were used for dry weight measurement. The rice plants were cut into small pieces and were placed in Aluminium trays. These cut pieces were then oven dried at 80OC for 48 hours and the oven dry weights (g) were determined.

### 2.5. Yield

A number of three plants were randomly selected from each replicate of the treatments at the end of ripening stage. Their panicles were harvested and the grains were obtained. After sum drying for two days, the seed weights were recorded and were converted to per hectare yield.

### 2.6. Analysis of data

The collected data were statistically analyzed using the Analysis of Variance (ANOVA) to detect significance if any at treatment level. The difference between treatments means was compared by the Duncan Multiple Range Test (DMRT) using SAS package version 9.1.

## 3. Results and Discussion

### 3.1. Plant height

There were significant ($p<0.05$) differences between treatments in the plant height of Bg ‘250’ rice cultivar during the vegetative stage (Table 1). The highest plant height was obtained in plants treated with 100% Nano-N fertilizer and the lowest was recorded in no fertilizer treatment. Hence, addition to fertilizer irrespective of the types has increased the height of rice cultivar ‘Bg 250’.

As indicated by Bahmaniar and Sooaee Mashaee (2010) nitrogen positively affects the plant height. Cells growth increase under nitrogen might be a reason for plant height rise. Several studies indicated that exogenous application of some nanoparticles can significantly improve plantgrowth (Mandeh et al., 2012; Song et al., 2013). Moreover, plant height was more enhanced when nano fertilizer was mixed with the conventional ones, even at a lower application rate (Benzon et al., 2015).

### 3.2. Number of tillers

There were significant ($p<0.05$) differences between treatments in the number of tillers of rice cultivar 'Bg 250' (Table 1). Application of 100% Nano-fertilizer gave the highest tiller number and the lowest was found in the control treatment where no fertilizer was added. Hence, it could be stated that addition of fertilizer (Chemical or Nano or coordination of both) has increased the number of tillers of rice plants.

For the most part, increasing trends in tiller number is viewed as a result of increased nitrogen rates. Similar work confirmed an increasing nitrogen rate increases the number of tillers Abdo et al.,(2012), Lampayan et al. (2010) have suggested that tiller number rise resulted from applying nitrogen fertilizer. The number of effective tillers produced is a good indicator as it is the major yield determinant. Tiller number has increased by an increase in Nitrogen level (Moro et al., 2015). The number of reproductive tillers was significantly affected by applying conventional fertilizer and in combination with Nano-fertilizer (Benzon et al., 2015).

### 3.3. Plant dry weight

There were significant ($p<0.05$) differences between the fertilizer treatments in the dry weight of rice cultivar 'Bg 250' during the ripening stage (Table 1). The highest dry weight was observed in the treatment which received 100% Nano – N fertilizer and the lowest was found in the control treatment where no fertilizers were added.

Manikandan and Subramanian (2016) has indicated that the highest dry matter yield in the maize obtained from nanozeourea treated soil may be attributed to the increased N availability due to reduced ammonia loss. Similar findings were recorded by (Liu and Liao, 2008) found that the activity of water after adding nano-materials was increased and N, P and K were absorbed into the plants with the absorbing of water, thus the dry matter production was also increased

### 3.4. Yield

There were significant ($p<0.05$) differences between treatments in the yield of rice cultivar 'Bg 250' during the ripening stage (Table 1). The highest yield was obtained in the treatment where 100% Nano N fertilizer was added. The control treatment where no fertilizers were added gave the lowest yield.

The researchers suggested that nano-fertilizers considerably influenced the straw yield and grain yield (Janmohammadi et al., 2016; Gao et al., 2013; Morteza et al., 2013; Klingenfuss, 2014; Tarafdar et al., 2014). Several studies proved the significance of nano-fertilizers. For instance, Sirisena et al. (2013) gained higher grain yield in rice via applying nano fertilizer. This is in agreement with the findings of Liu et al. (2009) reporting that nano-fertilizer application increased crop yield by 20% - 40%.

## 4. Conclusions

Application of 100% of Nano fertilizer has given the highest growth performance compared to the other treatments. Nitrogen losses occur through denitrification, volatilization and leaching which may cause air and water pollutions. Based on the present findings it could be concluded that replacing urea with nano nitrogen fertilizer has increases the growth and yield of rice cultivar "Bg 250". The application of Nano-N fertilizer can reduce harmful effects of nitrogen to the environment by reducing harmful nitrogen inputs.

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