GROWTH AND YIELD PERFORMANCES OF RICE (*Oryza sativa* L.) VARIETIES UNDER NANO-MICRONUTRIENT FERTILIZERS, NANO-CuO AND NANO-ZnO

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INTRODUCTION

Rice (*Oryza sativa* L.) is the second most important staple food in the world with the extent of 162.3 million hectares of rice cultivation (Hiyasmin *et al*., 2015). Micronutrients such as manganese, copper, boron, iron, molybdenum, and zinc are essential for increasing the growth of higher plants. Previous studies revealed that about 30% of the cultivated soils around the world are Zn deficient (Ahmad *et al*.,2012). In Sri Lanka, rice growing soils, particularly in poorly drained rice growing soils of mid country wet zone, dry and intermediate zones are deficient in Zn and Cu (Bandara and Silva, 2000; Nagarajah *et al*., 1983). Higher plants can absorb mineral nutrients when applied as foliar sprays in appropriate concentrations (Fageria *et al*., 2009). Nano- fertilizers have large surface area and particle size less than the pore size of leaves of the plant which can increase penetration into the plant tissues from applied surface and improve uptake and nutrient use efficiency (Qureshi *et al*., 2018). A recent study (Somaratne *et al*., 2021) revealed that foliar application of nano-ZnO fertilizer increased growth and specifically yield performances of rice varieties *Suwandal*, *Pachchaperumal* and Bg94-1. The objective of the present study is to evaluate growth and yield performances of selected rice varieties under nano-CuO and nano-ZnO micronutrient fertilizers.

METHODOLOGY

A pot-level experiment was carried out under greenhouse conditions with four rice varieties of three-and-half month category, Bg360, BW364, *Kalu Heenati* and *Kuruluthuda*. Nano- CuO, nano-ZnO and composite of nano ZnO-CuO -fertilizers were synthesized *via* Sol-gel method and Thermal decomposition method by using the metal acetates of the respective metal (Saravanan *et al*., 2011, 2012). The synthesized nano-fertilizers were characterized by X-ray Diffraction (XRD) and Scanning electron microscopy (SEM). Treatments were carried out at two stages during the bearing [at 48-58 Days after sowing (DAS)] and milking (filling) stage of grains [(100-105 DAS)]. Nano- fertilizers were used in spray applications at concentrations of 0 mg L^{-1}, 30 mg L^{-1},60 mg L^{-1} and 120 mg L^{-1} (T0, T1, T2 and T3). Growth related physiological parameters; plant height, number of leaves, number of tillers, and chlorophyll content (using SPAD meter) were recorded at 30 DAS, 60 DAS and 90 DAS and yield attributes were measured at the harvest. A CRBD (complete randomized block design) experimental design with three blocks and five replicates in each block was used. The data were subjected to descriptive analyses - mean, standard deviation, and analysis of variance to assess the significance between treatments using SPPS ver 20.

RESULTS AND DISCUSSION

The summary statistics of the ANOVA with interaction for the growth parameters are shown in Table 1. According to the table, interactions between concentration x element, concentration x rice variety, concentration x DAS, element x rice variety, element x DAS, rice variety x DAS, concentration x element x rice variety, element x rice variety x DAS, concentration x element x rice variety x DAS were significant ($p \leq 0.05$) for plant height. The interactions, concentration x element, concentration x rice variety, element x rice variety, element x DAS, concentration x rice variety x DAS, element x rice variety x DAS were not statistically significant ($p \leq 0.05$) for leaf chlorophyll content. The number of leaves and number of tillers depended on the variety, DAS and variety x DAS.

Table 1: Summary of the ANOVA of Plant height and Chlorophyll content with interactions

Source	**Plant height**	**Chlorophyll content**	**No.of leaves**	**No.of Tillers**
Concentration	.000	.000	.	.
Element	.000	.000	.	.
Variety	.000	.000	.000	.000
DAS	.000	.000	.000	.000
Concentration × Element	.000	.195	.	.
Concentration × Variety	.031	.825	.	.
Concentration × DAS	.206	.023	.	.
Element × Variety	.004	.148	.	.
Element × DAS	.000	.759	.	.
Variety × DAS	.000	.000	.000	.000
Concentration × Element ×	.020	.013	.	.
Concentration × Element × DAS	.058	.034	.	.
Concentration × Variety × DAS	.514	.104	.	.
Element × Variety × DAS	.000	.225	.	.
Concentration × Element × Variety × DAS	.008	.011	.	.

The summary statistics of ANOVA with interaction for the yield parameters are shown in Table 2. The variety, element, and the concentration had a significant effect ($p \leq 0.05$) on the number of panicles per plant. However, the interaction between the variety, element and concentration were not significant ($p \geq 0.05$). The variety, element, concentration and the interactions between those factors had a significant effect ($p \leq 0.05$) on the panicle length of the four rice varieties. The variety, element, concentration and the interactions between the factors had a significant effect ($p \leq 0.05$) on the number of grains per panicle of the four rice varieties. The variety, element, concentration and the interactions between the factors had a significant effect ($p \leq 0.05$) on the weight of 100 grains of the four rice varieties.

Table 2: Summary of ANOVA of Yield attributes with interactions ($p \leq 0.05$)

Source	**No. of Panicles per plant**	**Panicle length**	**Grains per panicle**	**100-grain weight**
Variety	.017	.000	.000	.000
Element	.032	.000	.000	.000
Concentration	.000	.000	.000	.000

Variety × Element	.162	.000	.000	.000
Variety × Concentration	.757	.000	.000	.000
Element × Concentration	.511	.000	.003	.000
Variety × Element × Concentration	.579	.000	.000	.000

The Mean number of panicles per plants in Bg360, Bw364, *Kaluheenati*, and *Kuruluthuda* was highest in CuO60 mgL-1, ZnO+CuO 60 mgL-1, and ZnO60 mgL-1. Comparatively, the number of panicles were higher in inbred varieties than traditional varieties. Mean panicle length in Bg360, Bw364, *Kaluheenati*, and *Kuruluthuda* was highest in CuO60 mgL-1, ZnO+CuO 60 mgL-1, and ZnO60 mgL-1. Mean panicle length was comparatively higher in two traditional varieties than the inbred varieties. The mean weight of 100grains in Bg360, Bw364, *Kaluheenati,* and *Kuruluthuda* was highest in CuO60 mgL-1, ZnO+CuO 60 mgL-1, and ZnO60 mgL-1. The weight of 100grains were comparatively higher in traditional varieties than in inbred varieties. Between Bg360 and Bw364, the latter showed a higher mean weight of 100grains as Bg360 has small grains compared to the other varieties. The mean number of grains per panicle in Bg360, Bw364, *Kaluheenati*, and *Kuruluthuda* was highest in CuO60 mgL-1, ZnO+CuO 60 mgL-1, and ZnO60 mgL-1. *Kuruluthuda* variety showed the highest number of grains per panicle out of four studied varieties.

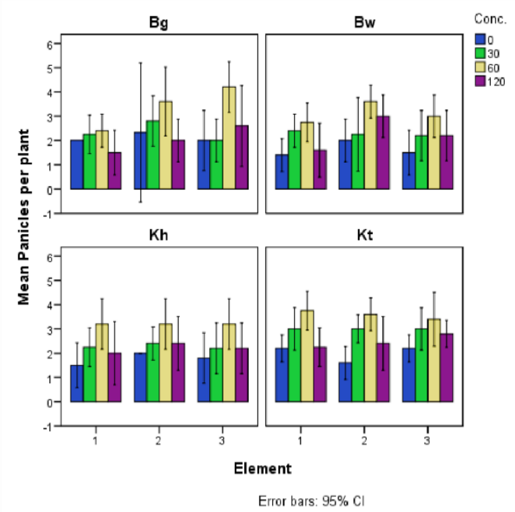

Figure 1: Mean number of panicles per plant with Different Nano fertilizer treatment in 4 different Rice varieties (1-Nano-CuO, 2- Nano-ZnO, 3-NanoCuO+Nano ZnO)

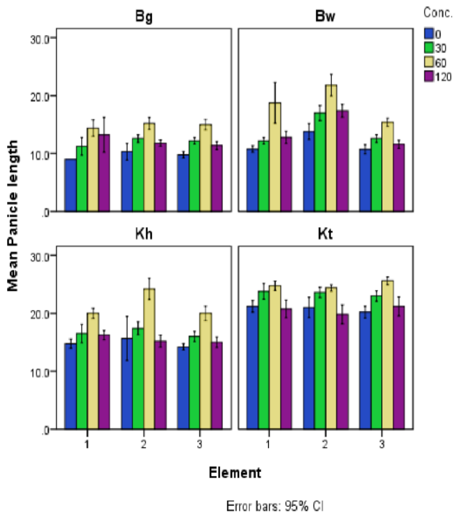

Figure 2: Mean Panicle length with Different Nano fertilizer treatment in 4 different Rice varieties (1-Nano-CuO, 2- Nano-ZnO, 3-NanoCuO+Nano ZnO)

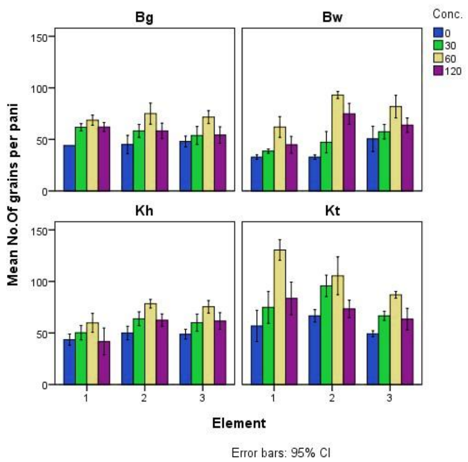

Figure 3: Mean Grains per panicle Different Nano fertilizer treatment in 4 different Rice varieties (1-Nano-CuO, 2- Nano-ZnO, 3-NanoCuO+Nano ZnO)

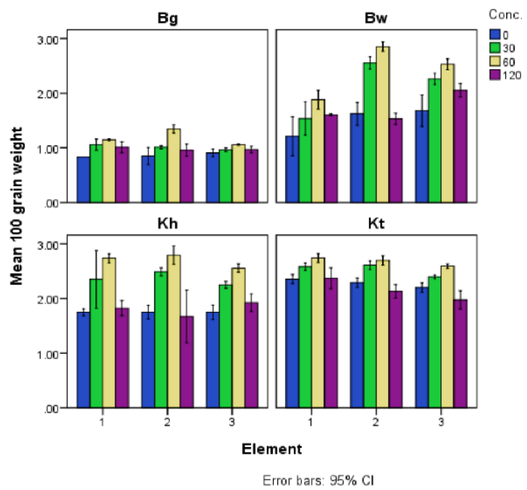

Figure 4: Mean of weight of 100 grains with Different Nano fertilizer treatment in 4 different Rice

varieties (1-Nano-CuO, 2- Nano-ZnO, 3-NanoCuO+Nano ZnO)

CONCLUSIONS/RECOMMENDATIONS

The selected rice varieties; Bg360, BW364, *Kalu Heenati* and *Kuruluthuda* exhibited increased plant height, number of tillers, number of leaves and chlorophyll content in response to the application of nano-fertilizers of CuO and ZnO. The number of panicles per plant, panicle length, number of grains per panicle and 100-grain weight significantly increased with the nano-fertilizer application. Yield increment in traditional rice varieties as well as in inbred varieties was prominent. Thermal decomposition and sol-gel methods proved to be rewarding methods in preparation of nano-CuO and nano-ZnO. Studies involving the application of nanotechnology in agriculture in Sri Lanka are still at an early stage, and in-depth investigations are required to optimize the concentration, frequency and the time of application of nano- fertilizers to rice varieties in a varietal specific manner to optimize the benefits.

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