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Response of rice cultivars to conventional and nano fertilizers on yield and yield attributes in the central plain zone of Punjab

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Abstract
A research trial was conducted during the *kharif* season at the Agricultural Research Farm of Lovely Professional University during 2020-2021. Rice varieties PR128 & PR129 were cultivated in Randomized Block Design (RBD) with ten treatments and three replications. The treatments were, Control- V1 (T1); Control- V2 (T2), V1 + Primed seedlings with 1% Zinc solution (T3); V1 + Non primed seedlings + RDF (T4), V1 + Foliar zinc @ 0.2% at 20 DAT (T5); V1 + Nano urea @ 2% + Nano zinc @ 2% (T6), V2 + Primed seedlings with 1% Zinc solution (T7), V2 + Non primed seedlings + RDF (T8), V2 + Foliar zinc @ 0.2% at 20 DAT (T9), V2 + Nano urea @ 2% + Nano zinc @ 2% (T10). The present study defined the effect of different treatments on the parameters of rice crops. It has been revealed from the results that the treatment T10 where PR129 was cultivated with the application of nano urea + nano zinc found the highest rice yield.

Keywords: Growth, nano urea, nano zinc, rice, yield

Introduction
Rice production in India is an important part of the national economy. Rice (*Oryza sativa* L.) belongs to the family Poaceae. Rice, the seed of grass species *Oryza sativa* is one of the most important cereal crops of *kharif* season. Rice is an excellent source of carbohydrates and protein, which has nutritious and possesses lesser crude fibre and fat (1 to 2%). About 20% of the world's dietary energy supplier is rice alone and higher than wheat or maize. In the 2020/2021 crop year, China produced over 148 million metric tons of milled rice, a higher volume than any other country, India came in second place with 122 metric tonnes of milled rice in that year. In India, West Bengal is the largest producer of rice. The area under rice in India in the year 2022/2021 is about 45,400 thousand hectares and in the year 2021/2022, the area increased to about 47,000 thousand hectares.
Zinc is an essential plant nutrient required for several biochemical processes in the rice plant, including chlorophyll production and membrane integrity. Zn is only slightly mobile in the plant and quite immobile in soil. The application of nano-zinc fertilizer can increase the Zn content of grains and promote root development and improve rice growth. The positive impacts of zinc oxide nanoparticles on cadmium levels alleviation in several plant species have also been reported. The N element has a vital role for rice crops, *i.e.*, it encourages faster crop growth, and improves grain yield and quality by increasing the number of tillers, leaf area development, grain formation, grain filling, and protein synthesis. Rice plants that are deficient in N have fewer tillers, stunted growth, yellowish-green leaves, and begin to die from the top and then to the middle of the leaf blade. If the N element is excessively given, causes weakening straw, crop fall, and decreasing the rice yield quality.
This paper deals with the comparative response of rice cultivars to conventional and Nano fertilizers on yield and yield attributes in the central plain zone of Punjab.

Materials and Methods
The experiment entitled ''Response of rice cultivars to conventional and nano fertilizers on yield and yield attributes in the central plain zone of Punjab'' was carried out at the research farm of Lovely Professional University, Punjab during the *kharif* season 2020-21. The site of the experiment was situated at 31°15′ N, 75°42′ E and 235 m from the mean sea level in Punjab.

The soils were characterized as slightly alkaline with a pH of 8 which was analyzed using the glass electrode method pH. Meter (Jackson, 1973) [1], electrical conductivity 0.21 dS/m analyzed using Conductivity bridge (Jackson, 1973) [1], available nitrogen 244 kg/ha by Kjeldahl method (Subbiahs and Assija, 1956) [2], available phosphorous 8.36 kg/ha by Olsen method (Olsen, 1954) [3] and available potassium 146.3 kg/ha by flame photometer. The experiment was laid out in Randomized Block Design (RBD) with ten treatments and three replications consisting of treatments Control- V1 (T1); Control- V2 (T2), V1 + Primed seedlings with 1% Zinc solution (T3); V1 + Non primed seedlings + RDF (T4), V1 + Foliar zinc @ 0.2% at 20 DAT (T5); V1 + Nano urea @ 2% + Nano zinc @ 2% (T6), V2 + Primed seedlings with 1% Zinc solution (T7), V2 + Non primed seedlings + RDF (T8), V2 + Foliar zinc @ 0.2% at 20 DAT (T9), V2 + Nano urea @ 2% + Nano zinc @ 2% (T10), where VI and V2 are the two rice varieties PR128 & PR129 which are used in the study. Data on yield and yield attributes were recorded by following the standard procedure adopted for rice cultivars. The data were analyzed to find out the significance of the experimental results and the difference among the treatment means was evaluated by DMRT (Gomez and Gomez, 1984) [4] at a 5% level of probability.

Results and Discussion

Yield and Yield attributes

The yield and yield attributes of rice cultivars were influenced by conventional and nano fertilizers and are presented in Table 1.

Number of panicles per plant

The significantly higher number of panicles per plant was found in V2 + Nano urea @ 2% + Nano zinc @ 2% (T10) i.e., 12.50 than all the rest of the treatments except V2 + Foliar zinc @ 0.2% at 20 DAT (T9), V2 + Non primed seedlings+ RDF (T8), V2 + Primed seedlings with 1% Zinc solution (T7), V1 + Nano urea @ 2% + Nano zinc @ 2% (T6), V1 + Non primed seedlings+ RDF (T4) and V1 + Primed seedlings with 1% Zinc solution (T3) which are statistically at par. The lowest number of panicles per plant was found in treatment in Control (V1) (T1) and V1 + Foliar zinc @ 0.2% at 20 DAT (T5) i.e., 7.67 (Fig.1.). Zinc improves the growth and increases the number of fertile tillers in rice by increasing absorption and providing other essential nutrients for the plant and by improving the metabolic process of the plant (Naik and Das, 2007) [5]. Application of Zn causes the allocation of more nutrients to plant reproductive parts, such as panicles and increases total dry matter accumulation (Amanullah and Inamullah, 2016) [6].

Number of grains per panicle

The significantly higher number of grains per panicle was found in V2 + Nano urea @ 2% + Nano zinc @ 2% (T10) i.e., 104.70 which was followed by V2 + Foliar zinc @ 0.2% at 20 DAT (T9), V2 + Non primed seedlings+ RDF (T8), V2 + Primed seedlings with 1% Zinc solution (T7), V1 + Nano urea @ 2% + Nano zinc @ 2% (T6), V1 + Foliar zinc @ 0.2% at 20 DAT (T5). The minimum number of grains per panicle was found in treatment Control (V1) (T1) i.e., 92.20 which was also found to be significantly lowest when compared with other treatments (Fig.1.). In this research, both foliar (nano) and soil application of Si and Zn caused the greatest increases in the filled grains number per panicle. ZnO NPs application enhanced NPK content in rice, with subsequence increasing panicle number, spikelet number per panicle and total biomass thereby promoting the rice yield (Yang *et al*., 2021) [7].

Test weight (g)

Maximum amount of test weight was found in treatment V2 + Primed seedlings with 1% Zinc solution (T7) i.e., 37.40 which is statistically at par with the treatments V2 + Nano urea @ 2% + Nano zinc @ 2% (T10) and V1 + Foliar zinc @ 0.2% at 20 DAT (T5). Minimum test weight was observed in the treatment Control (V1) (T1) i.e., 33.33. (Table 1.).

Grain yield and straw yield (kg/ha)

The highest grain yield was found in V2 + Nano urea @ 2% + Nano zinc @ 2% (T10) i.e., 69.43 kg/ha and is significantly higher than all other treatments. The minimum grain yield was found in treatment Control (V1) (T1) i.e., 62.20 kg/ha and is significantly lowest among other treatments (Fig.2.). In the case of straw yield results were like the grain yield as the highest amount of straw yield was also found in treatment V2 + Nano urea @ 2% + Nano zinc @ 2% (T10) i.e., 99.20 kg/ha and is statistically at par with the treatment V1 + Nano urea @ 2% + Nano zinc @ 2% (T6). The least amount of straw yield was found in the treatment Control (V2) (T2) i.e., 93.43 kg/ha and is significantly lowest when compared to other treatments (Fig.2.). Nano urea helps to store nitrogen in plant cell and release it slowly so that it protects the plant from biotic and abiotic stress and thereby increased the grain yield. These findings are in line with Midde *et al.,* (2022) [8]. Nano urea releases nutrients in controlled manner and regulates the plant growth. The application of the same enhanced the activity of target sites which thereby led to increase the biological production of crop. These findings are in line with DeRosa *et al.,* (2010) [9], Nair *et al*., (2010) [10] and Midde *et al.,* (2022) [8]. Performance as compared with conventional products. Further it was also observed that ZnO NPs enhanced chlorophyll synthesis in leaves by affecting the activities of glutamyl-tRNA reductase and protoporphyrinogen oxidase (Siddiqui *et al*., 2019) [11], leading to higher grain yields and better rice qualities of ZnO NPs treatments (Zhang *et al*., 2021) [12].

Summary and Conclusion

The present study revealed that application of V2 + Nano urea @ 2% + Nano zinc @ 2% (T10) produced significantly higher number of panicles per plant, number of grains per panicle, grain yield and straw yield. The highest test weight was obtained with V2 + Primed seedlings with 1% Zinc solution which was at par with V2 + Nano urea @ 2% + Nano zinc @ 2%. Based on the study to obtain high yield parameters application of V2 + Nano urea @ 2% + Nano zinc @ 2% can be suggested to farmers.

Table 1: Representing the response of rice cultivars to conventional and nano fertilizers on yield and yield attributes in the central plain zone of Punjab

Treatments	No. of panicles per plant	No. of grains per panicle	Grain Yield	Straw Yield	Test weight
T1- Control (V1)	7.67	92.20	62.20	95.07	33.33
T2- Control (V2)	8.00	96.50	63.57	93.43	34.53
T3- V1 + Primed seedlings with 1% Zinc solution	8.67	97.50	61.63	94.37	34.43
T4- V1 + Non primed seedlings+ RDF	8.67	96.17	61.90	92.50	36.20
T5- V1 + Foliar zinc @ 0.2% at 20 DAT	7.67	94.73	63.83	94.40	36.97
T6- V1 + Nano urea @ 2% + Nano zinc @ 2%	8.67	98.70	68.27	97.43	36.40
T7- V2 + Primed seedlings with 1% Zinc solution	8.33	98.47	65.90	96.53	37.40
T8- V2 + Non primed seedlings+ RDF	10.00	99.10	66.40	96.27	36.27
T9- V2 + Foliar zinc @ 0.2% at 20 DAT	11.00	101.87	66.37	96.67	35.63
T10- V2 + Nano urea @ 2% + Nano zinc @ 2%	12.50	104.70	69.43	99.20	37.20
CD (P = 0.05)	4.24	0.80	0.610	2.00	0.59

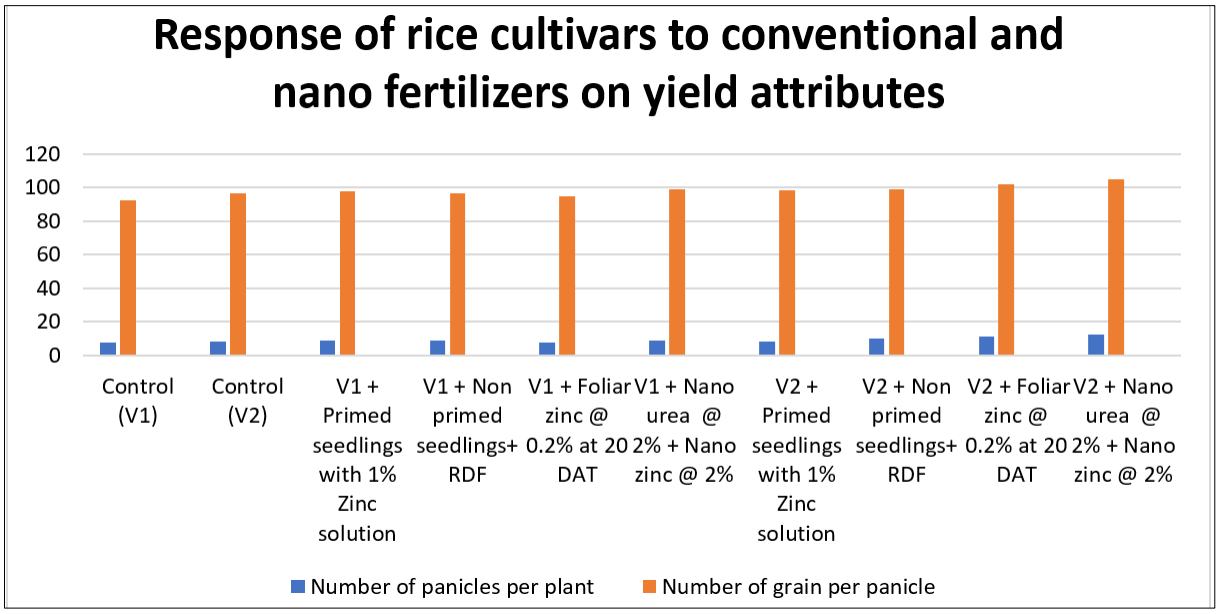

Fig 1: Representing the response of rice cultivars to the conventional and nano fertilizers on yield attributes of rice

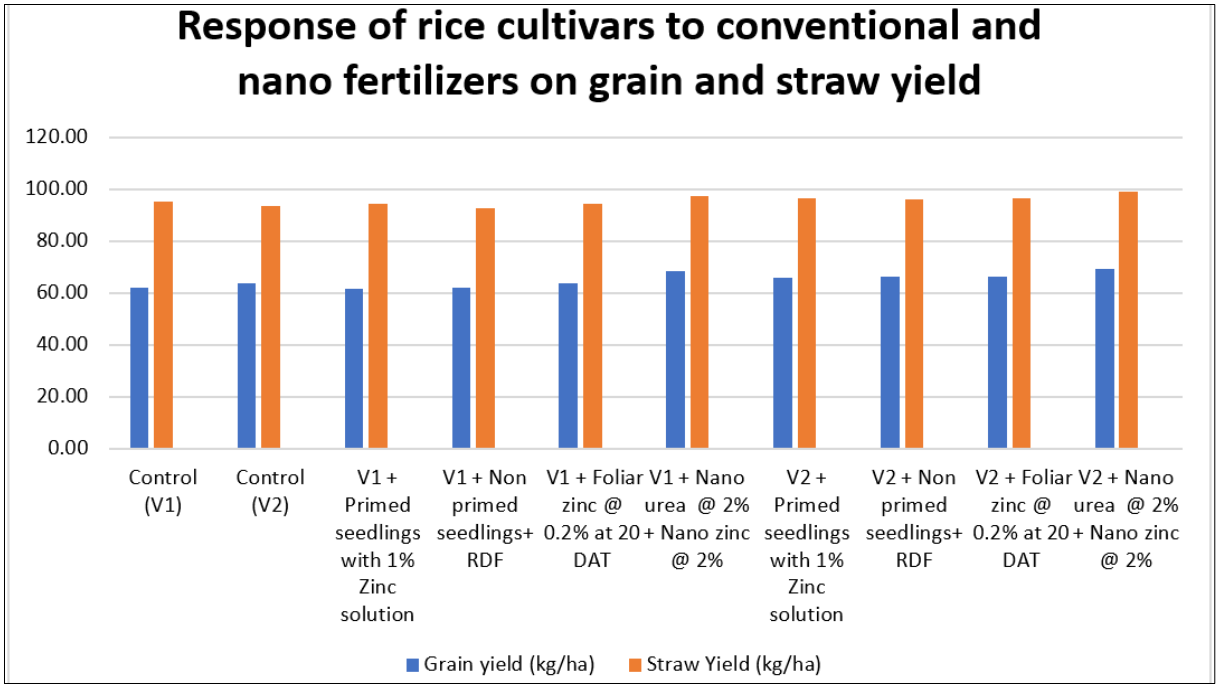

Fig 2: Representing the response of rice cultivars to the conventional and nano fertilizers on grain and straw yield of rice

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