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Effect of foliar spray of nano nitrogen and nano zinc on growth, development, yield and economics of rice (*Oryza sativa* L.)

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Abstract
A two-year field experiment was undertaken during *kharif* 2021 and *kharif* 2022 at the Experimental Farm of Department of Agronomy, CSK Himachal Pradesh Krishi Vishwavidyalaya, Palampur (H.P.) with the objective to study the effect of Nano N and Nano Zn on growth, development, and yield of rice (*Oryza sativa* L.). in mid-hills of Himachal Pradesh. The experiment consisted of fourteen treatments and three replications with randomized block design (RBD). The treatment consisted of different levels of conventional nitrogen fertilizer with or without sprays of Nano nitrogen (@ 4 ml/l.) and/or Nano zinc (@ 2 ml/l.) The fertilizer dose for red-rice was 60:30:30 kg/ha with HPR 2795 (Him Palam Lal Dhan 1) as variety. The soil of the experimental site was silty clay loam in texture, acidic in reaction and medium in available nitrogen, phosphorus and potassium and zinc. The results obtained from the present investigation clearly indicated the significant influence of different N level treatments (100, 75 or 50% N) with or without Nano N and/or Nano Zn application on the growth, yield and economics of rice, though development parameters were not influencing significantly. Application of treatment, T_4: 100% N along with single combined spray of nano nitrogen and nano zinc gave significantly higher values of plant height at all stages of observations as well as grain yield (34.9 q/ha and 33.9 q/ha) during both the years 2021 and 2022 though it was at par with treatment application of T_9: 75% N supplemented with double combined sprays of nano nitrogen and nano zinc (33.5 q/ha and 32.5 q/ha). This treatment also proved to be the most remunerative one giving higher B:C ratio (1.40 and 1.33) during both the years. Foliar nano zinc application to the crop increased the grain yield of rice. Thus, treatment T_4: 100% N along with single combined spray of nano nitrogen and nano zinc is considered to be the best treatment for growth, grain yield and BC ratio in rice crop, though it was at par with treatment, T_9: 75% N supplemented with double combined sprays of nano nitrogen and nano zinc in terms of plant height and grain yield. Since, lodging was not reported in crop during both the years hence, lodging score was zero.

Keywords: Nitrogen, nano nitrogen, nano zinc, rice, growth, yield

Introduction
Rice (*Oryza sativa* L.) crop provides food for almost half of the world's population, accounting for over 21% of human caloric requirement and upto 76% of calorific intake of southeast-Asian inhabitants (Zhao *et al*. 2020) [1]. It is considered as the staple food of our country with its cultivation, the primary economic activity and main source of income for many Indian rural-households. In India, rice is grown in an area of 45.77 million hectares with a total production of 124.37 million tonnes and average productivity of 2717 kg ha^{-1} (Anonymous, 2021) [3]. Being one of the most important crops and second only to maize as *kharif* crop of Himachal Pradesh. It is grown in an area of 71.81 thousand hectares with a production of 114896 metric tonnes and productivity of 1600 kg ha^{-1}. (Anonymous, 2020) [2]. Moreover, interest of researchers on traditional or specialty rice has increased in recent years, red-rice is one such type. There has been a spectacular increase in the production and productivity of rice over the past few decades in our country, due to the cultivation of high-yielding varieties with improved cultivation practices adopted, including fertilizer use and irrigation management. But, the sustainability of this system has been questioned by many due to stagnating yields, degradation of natural resources including soil, groundwater as well as atmosphere. Moreover, it has also led to reduced use efficiencies of the applied nutrients. In cereals, the nutrient use efficiency of nitrogen is about 44% (Ladha *et al*. 2005) [6] in general, whereas, it is up to 33% in rice (Prasad *et al*. 2014) [4]. The low N use efficiency in rice and other crops is attributed to more and more losses through, surface run-off, ammonia

volatilization, leaching and denitrification. Better nutrient use efficiency (NUE) can directly reduce the potential of pollution from nitrogenous fertilizer. In addition, increasing NUE also increases rice yield. Further, soils formed under different agro-climatic conditions differ in their zinc bioavailability. Nearly half of the world's cereal growing area is affected by soil zinc deficiency. Farmers are using both sulphates and chelated Zn (with ethylene di ammine tetra acetic acid, EDTA) for soil and foliar applications; however, the efficacy is low. and hence, it is important to develop technologies that can increase the use efficiency of applied nutrients.

Nanotechnology, an innovative approach of utmost importance in present agriculture with a focus on improving crop growth, yield, quality with better nutrient use efficiency, reduced wastage of applied nutrients, and cost of cultivation. In fact, the country is in the need of a "Second Green Revolution," and nano fertilizers are envisioned to have the potential to revolutionize agriculture. Nano fertilizers appear better option, as these sources of nutrients have the potential to increase the crop productivity and are more environment friendly than synthetic fertilizers (Seleiman *et al*. 2021) [5]. Therefore, the present investigation was conducted to assess the impact of foliar application of nano fertilizers and their combinations with nitrogen levels on the growth and development studies of red-rice.

Material and Methods

A two-year field experiment was carried out at Research Farm of Department of Agronomy, College of Agriculture, CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur during *kharif* 2021 and *kharif* 2022, to study the effect of Nano N and Nano Zn on growth, development, and yield attributes of rice (*Oryza sativa* L.). The experimental site was at 32º 06' N latitude, 76° 54′ E longitude and at an altitude of 1290 m above mean sea level. Experimental site falls under sub-temperate mid hill zone of Himachal Pradesh. It lies in North-West Himalaya in the Palam Valley of Kangra district of Himachal Pradesh, India. Soil of the experimental site was silty clay loam in texture, acidic in reaction, medium in available nitrogen, phosphorus, and potassium The experiment was conducted in a Randomized Block Design (RBD) with fourteen treatments and three replications. The treatment details are as such; T_1: 100% N, T_2: 100% N +1 spray Nano N, T_3: 100% N+1 spray Nano Zn, T_4: 100% N+ 1 spray Nano N and Nano Zn, T_5: 75% N, T_6: 75% N+2 spray Nano N, T_7: 75% N+2 spray Nano Zn, T_8: 75% N+ 1 spray Nano N and Nano Zn, T_9: 75% N+ 2 spray Nano N and Nano Zn, T_{10}: 50% N, T_{11}: 50% N+ 2 spray Nano N, T_{12}: 50% N+ 2 spray Nano Zn, T_{13}: 50% N+ 1 spray Nano N and Nano Zn, T_{14}: 50% N+ 2 spray Nano N and Nano Zn. The RDF for rice was 60:30:30 kg/ha with variety of red-rice, HPR 2795 (Him Palam Lal Dhan 1)

Result and Discussions

Plant height

Data pertaining to the effect of different N level treatments with or without nano spray application on plant height (cm) at periodic intervals and at harvest have been given in Table 1. Plant height of rice was significantly affected by different N level treatments with or without nano spray application at all stages of observation.

At 30 DAS, significantly taller rice plants were recorded with the application of 100% N along with single combined spray of Nano N and Nano Zn though this treatment was at par with all other treatments in which either 100% N or 75% N was applied with or without application of Nano N and / or Nano Zn. Significantly, lower plant height of rice was recorded with application of 50% N though this treatment was at par with all other treatments in which this N level was supplemented with single or double spray of Nano N or Nano Zn. Hence, we can say that difference due to Nano spray was not visible at 30 DAS as 1st spray of these were done only at tillering stage and hence effect was not observed.

Nano spray effects were observed at later stages i.e., at 60 DAS, 90 DAS and at harvest (Table 1), because sprays were done at tillering and pre-flowering stages. Significantly taller plants were recorded with the application of 100% N supplemented with single combined spray of Nano N and Nano Zn at 60, 90 DAS and at harvest. As upto 60 DAS, only one spray was complete hence, this treatment was found to be at par with 100%N with or without spray of Nano N and/or Nano Zn as well as with the application of 75% N in combination with single or double sprays of Nano N + Nano Zn.

Whereas, upto 90 DAS and at harvest, second spray of nano has also been done hence, treatment with significantly taller plants, T_4 was found to be at par with all treatments where 100% N was applied with or without spray of Nano N and/or Nano Zn as well as with 75% N with double sprays of either nano N alone or combined sprays of nano N + nano Zn. However, significantly lower plant height was recorded with 50% N application alone at all stages of observations.

Taller plants recorded with the application of higher dose of fertilizer application might be due to increased availability of nutrients, especially nitrogen during initial growth stages which might have resulted in better root and shoot growth. Further, nano-sprays of nitrogen and zinc due to their unique properties of nano size particles and higher surface area helps in easier and efficient uptake of nutrients inside plant parts. Zinc in addition, has an important and crucial role in various physiological and biochemical processes resulting in improved metabolism of growing plants, cell and internodal elongation and increased availability of zinc also resulted in improving photosynthetic activity and ultimately increased plant height. Moreover, nitrogen and zinc application were reported to have positive interaction in combination and have resulted in higher plant height. Significantly, shorter plants were recorded at 50% N treatment without any spray, which could be attributed to inadequate supply of nutrients, mainly nitrogen to rice crop, particularly during initial stages of plant growth which resulted in poor crop growth. The results of increased plant height with higher nitrogen fertilization have also been reported by Verma *et al* (2017) [8].

Moreover, beneficial effects of Zinc on height of plant were also reported by Sudha and Stalin (2015) [7].

Developmental studies

Days taken to 50% flowering was not significantly influenced by different nitrogen levels with/ without nano sprays during both the years. As total number of days taken by a particular variety to reach a particular development stage of crop life cycle is mainly a varietal character and depends on weather conditions, mainly temperature (GDD's) with very little or

mere influence of crop cultivation practices. Hence, its already clear from Table 2 that different N level treatments with or without nano spray application failed to exhibit any significant effect on days to reach 50% flowering. However, numerically a greater number of days were taken with the application of 100% N along with single combined spray of nano nitrogen during both the years while lesser number of days were taken with the application of 50% N along with two combined sprays of nano N and nano Zinc during both the years (2021 and 2022).

Similarly, days taken to physiological maturity was not found to be significantly affected by respective treatments. As days to physiological maturity is also a developmental character hence, in totality, different treatments failed to express any significant effect, during both the years (2021 and 2022). The reasons for this have already been discussed. However, numerically a greater number of days were taken with the application of 100% N without spray while lesser number of days were taken with the application of 50% N along with 2 sprays of Nano N and Nano Zn in combination during both the years (2021 and 2022) as given in Table 2.

Crop lodging is the bending of crop stems from their upright position It is basically a major yield reducing factor of cereals as it causes deterioration of grain quality. The severity of lodging can be measured by a lodging score (LS) parameter; an index calculated from crop angle of inclination (CAI) and crop lodged area (LA). As lodging was not reported from any treatment in the field during both the years (2021 and 2022) which can also be seen and confirmed from Table 2. Hence, we can submit that the value of lodging score is zero or nil implying, no lodging due to different treatments.

Yield and B:C ratio

Significantly higher grain yield was recorded with the application of 100% N along with single combined spray of nano nitrogen and nano zinc, though this treatment was found to be at par with all the treatments in which 100% N was applied in combination with the application of Nano N and/or Nano Zn during both the years (2021 and 2022) as well as with the application of 75% N with two combined sprays of nano nitrogen + nano zinc during both years (2021 and 2022). Whereas, treatment in which only 50% N was applied alone gave significantly lower grain yield during both the years (2021 and 2022). With the application of lowest dose (50% N), the availability of nutrients could have been considerably lower than the requirement of rice crop and hence application resulted in lower yield.

Adequate availability of nutrients at the initial stages of crop growth due to their higher application rates might be the reason for better tillering and initial plant growth. Further, application of nano fertilizers due to their unique properties of nano sized particles with higher surface area resulted in more efficient absorption resulting in higher uptake of available nutrients. Thus, foliar spray had resulted in better reproductive growth and yield attributes and ultimately higher yield. Nitrogen application at later stages in split application also kept the plants healthy and green for longer period ensuring high photosynthetic efficiency, anthesis and hence higher yield. Similar, results reported by Patel and Mishra (2014) [9]. It is also evident from Table 3 that zinc application using foliar spray had also increased the grain yield of rice when used in combination with nitrogen or when nitrogen requirement is fulfilled adequately, reflecting the positive interaction between nitrogen and zinc. Zinc plays an important role in various physiological processes, being a cofactor of almost 300 enzymes involved in the metabolism of lipids, proteins, carbohydrates, and nucleic acids. (Sadeghzadeh, 2013) [11].

Mustafa *et al*. (2011) [10] quoted similar findings of increase in grain yield of rice due to zinc application. Higher grain yield with the application of 100% N along with 1 spray of Nano N + Nano Zn might be due to better values of contributing characters or yield attributes (Table 3). At the end, significantly lower yield with 50% N application could merely be attributed to lack of primary nutrient mainly nitrogen and also absence of zinc as foliar spray. Grain yield obtained from treatment with application of 75% N from conventional urea along with 2 sprays of Nano N (@ 4 ml/ltr.) alone, was statistically alike with the grain yield obtained from the 100% N from conventional urea during both seasons (2021 and 2022).

Since**,** the ground level effectiveness of any scientific practice or treatment basically depends upon B:C ratio which indicates the net returns achieved per rupee invested. General increase in B: C ratio with increasing fertilizer application was due to increased grain and straw yield obtained. Also, the additional cost of application of nano nitrogen and nano zinc sprays was fully compensated by additional returns obtained from increasing yield.

Among all the treatments, BC ratio was recorded highest in Treatment no. 4 (100% N with one combined spray of Nano+ Nano Zn) i.e., 1.40 and 1.33 respectively during both the years 2021 and 2022 which, was almost same or like with treatment, T_2 (100% N with single Nano N spray) i.e., 1.40 and 1.32 respectively. While, lowest recorded value of BC ratio was observed in 50% N with 2 sprays of Nano Zn i.e., 0.92 and 0.79. This could be attributed to the reason that although with Zn spray; grain and straw yield was increased but this increase was not proportionate to zinc spray in treatment, as treatment cost was higher, then the additional benefit received from 50% N along with two sprays of nano zinc alone.

Table 1: Effect of different fertilizer treatments on plant height (cm) of rice at periodic intervals

Treatment Details	30 DAS		60 DAS		90 DAS		At harvest	
	Kharif 2021	*Kharif* 2022	*Kharif* 2021	*Kharif* 2022	*Kharif* 2021	*Kharif* 2022	*Kharif* 2021	*Kharif* 2022
T_1: 100% N	38.0	36.5	77.8	75.8	96.6	93.8	101.8	98.6
T_2: 100% N +1 spray Nano N	38.2	36.6	79.2	77.1	98.3	95.4	103.7	100.2
T_3: 100% N+1 spray Nano Zn	37.8	36.3	78.3	76.2	97.2	94.2	102.4	99.1
T_4: 100% N+ 1 spray Nano N and Nano Zn	38.4	36.8	81.5	79.3	101.1	98.1	108.4	104.8
T_5: 75% N	36.7	35.3	75.6	73.6	91.8	89.0	97.1	93.9
T_6: 75% N+2 spray Nano N	36.5	35.0	77.0	74.9	95.8	92.9	101.7	98.3
T_7: 75% N+2 spray Nano Zn	36.8	35.3	76.0	74.0	93.5	90.7	98.7	95.4
T_8: 75% N+ 1 spray Nano N and Nano Zn	36.9	35.4	77.9	75.8	94.7	91.8	100.0	96.7
T_9: 75% N+ 2 spray Nano N and Nano Zn	37.0	35.5	78.0	76.0	96.7	93.8	102.2	98.8
T_{10}: 50% N	34.0	32.6	70.0	68.2	85.3	82.7	91.2	88.2
T_{11}: 50% N+ 2 spray Nano N	34.8	33.4	72.4	70.5	90.7	88.0	96.0	92.7
T_{12}: 50% N+ 2 spray Nano Zn	34.6	33.2	72.0	70.1	87.7	85.0	93.0	89.9
T_{13}: 50% N+ 1 spray Nano N and Nano Zn	35.0	33.6	74.1	72.1	88.7	86.1	94.3	91.1
T_{14}: 50% N+ 2 spray Nano N and Nano Zn	35.6	34.2	74.6	72.6	91.6	88.8	97.5	94.2
SEm±	0.7	0.6	1.5	1.3	1.9	1.8	2.5	2.3
LSD (P=0.05)	2.1	1.8	4.4	3.9	5.6	5.3	7.2	6.6

DAS: Date after sowing, 1st Spray at tillering stage and 2nd spray at pre-flowering stage, Nano N dose @ 4 ml/l and Nano Zn dose @ 2 ml/l

Table 2: Effect of different fertilizer treatments on days to 50% flowering, days to physiological maturity and Lodging score of rice

Treatment Details	Days to 50% flowering		Days to physiological maturity		Lodging score	
	Kharif 2021	*Kharif* 2022	*Kharif* 2021	*Kharif* 2022	*Kharif* 2021	*Kharif* 2022
T_1: 100% N	82.5	80.0	123.5	121.0	0	0
T_2: 100% N +1 spray Nano N	82.7	80.2	123.4	120.8	0	0
T_3: 100% N+1 spray Nano Zn	82.3	79.8	123.4	120.9	0	0
T_4: 100% N+ 1 spray Nano N and Nano Zn	82.0	79.5	122.9	120.4	0	0
T_5: 75% N	81.8	79.3	122.7	120.2	0	0
T_6: 75% N+2 spray Nano N	81.1	78.6	122.1	119.6	0	0
T_7: 75% N+2 spray Nano Zn	81.0	78.5	121.9	119.4	0	0
T_8: 75% N+ 1 spray Nano N and Nano Zn	79.9	78.4	121.8	119.3	0	0
T_9: 75% N+ 2 spray Nano N and Nano Zn	80.5	78.0	121.7	119.2	0	0
T_{10}: 50% N	80.9	78.4	121.8	119.3	0	0
T_{11}: 50% N+ 2 spray Nano N	80.3	77.8	121.2	119.7	0	0
T_{12}: 50% N+ 2 spray Nano Zn	80.2	77.7	121.0	118.5	0	0
T_{13}: 50% N+ 1 spray Nano N and Nano Zn	80.1	77.6	121.0	118.5	0	0
T_{14}: 50% N+ 2 spray Nano N and Nano Zn	79.8	77.4	120.9	118.4	0	0
SEm±	0.3	0.4	0.4	0.4	-	-
LSD (P=0.05)	NS	NS	NS	NS	-	-

Table 3: Effect of different fertilizer treatments on grain yield (q/ha) and B: C ratio in rice crop

Treatment Details	Grain Yield (q/ha)		B:C ratio	
	Kharif 2021	*Kharif* 2022	*Kharif* 2021	*Kharif* 2022
T_1: 100% N	31.9	30.9	1.36	1.28
T_2: 100% N +1 spray Nano N	34.1	32.9	1.40	1.32
T_3: 100% N+1 spray Nano Zn	33.6	32.5	1.36	1.28
T_4: 100% N+ 1 spray Nano N and Nano Zn	34.9	33.9	1.40	1.33
T_5: 75% N	30.2	29.0	1.24	1.15
T_6: 75% N+2 spray Nano N	31.9	30.8	1.17	1.09
T_7: 75% N+2 spray Nano Zn	31.4	30.3	1.11	1.03
T_8: 75% N+ 1 spray Nano N and Nano Zn	31.7	30.6	1.19	1.11
T_9: 75% N+ 2 spray Nano N and Nano Zn	33.5	32.5	1.16	1.10
T_{10}: 50% N	26.6	25.1	0.98	0.87
T_{11}: 50% N+ 2 spray Nano N	29.5	27.7	1.01	0.89
T_{12}: 50% N+ 2 spray Nano Zn	28.4	26.5	0.92	0.79
T_{13}: 50% N+ 1 spray Nano N and Nano Zn	28.8	27.5	1.00	0.90
T_{14}: 50% N+ 2 spray Nano N and Nano Zn	30.7	28.8	0.99	0.86
SEm±	1.0	0.9	1.36	1.28
LSD (P=0.05)	2.9	2.6	1.40	1.32

Conclusion

Application of nanotechnology in agriculture is still in its budding stage. However, it has the potential to revolutionize agricultural systems particularly where the issues on fertilizer applications are concerned. Here, application of 100% N along with single combined spray of nano nitrogen and nano zinc resulted in significantly higher plant height at all stages of observations, grain yield and BC ratio during both the

years. Days to 50% flowering and days to physiological maturity, these phenophases were not significantly influenced by different treatments. Even, the lodging was not reported in rice field during both the years. T_4: 100% N+ 1 spray Nano N and Nano Zn, treatment was the best treatment reported in this study though it was at par with T_9: 75% N+ 2 spray Nano N and Nano Zn treatment.

References

1. Zhao M, Lin Y, Chen H. Improving nutritional quality of rice for human health. Theor. Appl. Genet. 2020;133:1397-1413.
2. Anonymous. India-stat; c2020. https://www.indiastat.com/data/agriculture/agricultural-area-land-use.
3. Anonymous. India-stat; c2021. https://www.indiastat.com/data/agriculture/agricultural-area-land-use.
4. Prasad R, Pathak H, Patra AK, Shivay YS. Nitrogen management. pp. 73–92. (In) A Text Book of Plant Nutrient Management (Prasad R, Kumar D, Rana D, Shivay YS and Tewatia RK, Eds.), Indian Society of Agronomy, New Delhi; c2014.
5. Seleiman MF, Almutairi KF, Alotaibi M, Shami A, Alhammad BA, Battaglia ML, *et al*. Nano-Fertilization as an Emerging Fertilization Technique: Why Can Modern Agriculture Benefit from Its Use? Plants. 2021;0:2.
6. Ladha JK, Pathak H, Krupnik TJ, Six J, Van Kessel C. Efficiency of fertilizer nitrogen in cereal production: retrospect and prospects. Adv. Agron. 2005;87:85-156. DOI: 10.1016/S0065-2113(05)87003-8
7. Sudha S, Stalin P. Effect of zinc on yield, quality, and grain zinc content of rice genotypes. International Journal of Farm Sciences. 2015;5(3):17-27.
8. Verma JK, Akhtar Ali A, Harikesh, Shivam. Effect of various nutrient management modules on growth and yield traits of high yielding varieties of Rice (*Oryza sativa* L.). Journal of Pharmacognosy and Phytochemistry. 2017;6(5):697-701.
9. Patel T, Mishra VN. Effect of different fertility levels on yield and other plant characters of drought tolerant rice genotypes. SKUAST Journal of Research. 2014;16(2):30-37
10. Mustafa G, Ehsanullah, Akbar N, Qaisrani1 SA, Iqbal A, Khan HZ, *et al*. Effect of zinc Application on growth and yield of rice (*Oryza sativa* L.). International Journal for Agro Veterinary and Medical Sciences. 2011;5(6):530-535.
11. Sadeghzadeh B. A review of zinc nutrition and plant breeding. Journal of soil science and plant nutrition. 2013 Dec;13(4):905-927.