Effect of Nano Zinc and Consortia on Growth, Yield Attributes and yield of Rice (Oryza sativa) in Central Zone of Uttar Pradesh

Abstract

The field study titled "Effect of Nano Zinc and Consortia on Growth and Yield Attributes of Rice (*Oryza sativa*) in Central Zone of Uttar Pradesh" was conducted to evaluate the impact of various nutrient doses and sources on rice growth, yield, and soil quality. Fourteen treatments, including combinations of NPK (Nitrogen, Phosphorus, Potassium), farmyard manure (FYM), consortia, and nano zinc, were laid out in a randomized block design with three replications. Treatment T_8 (75% NPK + FYM @ 5 tons/ha + Consortia + Nano Zinc) consistently produced superior results across all parameters.The highest plant height was recorded in T_8 (75% NPK + FYM @ 5 ton/ha + Consortia + Nano zinc), with values of 57.79 cm at 30 DAT, 84.79 cm at 60 DAT, 95.27 cm at 90 DAT, and 97.09 cm at harvest, compared to the control (T_1), which had 46.96 cm, 66.12 cm, 71.23 cm, and 75.83 cm, respectively. T8 also showed the maximum dry matter accumulation (36.49 g/m²), effective tillers (181.20 tillers/m²), and number of grains per panicle (87.44). Grain yield was significantly higher in T8, reaching 43.6 q/ha, compared to the control (T_1) at 19.79 q/ha. Similarly, the biological yield in T8 was 122.39 q/ha, far exceeding the control (T_1: 62.78 q/ha).The study concludes that integrating FYM, consortia, and nano zinc with reduced NPK application can significantly enhance rice growth, yield, and profitability, demonstrating its potential for sustainable rice production in Uttar Pradesh.

Keywords: Nano Zinc, Consortia, NPK, FYM, Rice Yield,

1. INTRODUCTION

Basmati rice is unique among other aromatic long-grain rice varieties. Owning to its unique characteristics the “scented Pearl” lends a touch of class that can transform even the most ordinary meal into a gourmet’s delight.Rice is the world's major staple food crop. It is the rich source of energy and contains reasonable amount of protein (6-10%), carbohydrate (70-80%), mineral (1.2-2.0%) and vitamin (Riboflavin, Thiamine, Niacin and Vitamin E) (Anonymous, 2014). It is the main source of high-calories energy, high biological value (BV) and good protein efficiency ratio (PER) **(Verma & Shukla, 2011; Vlachos & Arvanitoyannis, 2008).** Because of the reason of its nutritional quality and higher digestibility, rice is regarded as the queen among cereals.

Organic manures serve as the carbon and energy source for the proliferation of microorganisms which may alter the activities of different enzymes. The incorporation of organic manures in the soil affects the chemical and biological environment but also affects the nutrient availability to crop plants and microorganisms. A promising approach is to develop effective fertilization strategies that can encourage agricultural sustainability by promoting soil microbial biomass and operation by integrating organic modifications with reduced chemical fertilizer**(Mandal *et al.*, 2007).** The quality parameters of scented rice are improved by biofertilizers alone or in combination with organic manure **(Dixit & Gupta, 2000; Quyen & Sharma, 2003).** To supplement part of the nitrogen requirement with ecological and economic significance, blue-green algae (BGA) and Azospirillum can be successfully used in wetland rice**(Anjum *et al.*, 2007).**

To ensure food security in the world's rice-consuming countries, those countries would need to grow 50 percent more quality-enhanced rice to meet market demand by 2025. With less water, less energy and less pesticides, this additional rice would have to be grown on less ground. When rice quality preferences gradually receive more attention, the task becomes even more difficult. Improving and managing crops has played an important role in the past in raising the production of major food crops. Improving and maintaining soil quality for sustaining agricultural production is the most important issue.

Organic farming is one of the most widely practiced, diversified farming system to make agriculture sustainable, which is an ecological production management system that promotes and enhance biodiversity, biological cycle and soil biological activity. The use of organic manure for improving and maintaining the soil health has been in practice since long time, but its practicability is limited due to poor availability, and higher cost of nutrients supplied through organic sources. Balance fertilization to crop through Inorganic and organic manures like farmyard manure, vermicompost, neem cake, poultry manure, crop residues and green manuring are prerequisites to sustain soil fertility, to produce maximum crop yield with optimum input level and also natural biological pest control and plant protection measures to promote agro-economic system and soil biological activity **(Rosati*et al.*, 2021).**

Farm yard manure (FYM) is the most commonly used organic manure in most countries of the world. Farm Yard Manure application leads to improves soil structure, nutrient exchange, and maintains soil health thus very useful for INM or organic farming. FYM is a heterogeneous composted organic material consisting of dung, crop residue, and household sweeping in various stages of decomposition. It also had effect on residual phosphorus and potassium in soil. FYM is rich in nutrients and contains 0.5% Nitrogen, 0.2%

Phosphorus and 0.5% Potassium. Application of FYM improves soil fertility and soil physical properties like soil structure, aeration, water holding capacity etc**(Haque *et al.*, 2015).**

The concept of Integrated Nutrient Management (INM) is aimed to continuous improvement of soil productivity on long term basis through appropriate use of inorganic fertilizers, organic manures, biofertilizers, green manures, crop residues and legume inter-cropping and their scientific management for optimum growth, yield and quality of different crops and cropping systems in specific agro-ecological situations and ensuring environmental safety**(Selim, 2020).**

2. MATERIALS AND METHODS

3.1 Experimental site and location

The field experiments were conducted at Crop Research Centre of Chandra Shekhar Azad University of Agriculture & Technology, Kanpur (Uttar Pradesh) during *kharif* season 2021 and 2024. Kanpur is situated on the Ravatpur–Kalyanpur Road. Geographically Kanpur is located at latitude of 26.4499° North and longitude of 80.3319° East and at an altitude of 126 meter (413 ft) above mean sea level (MSL) in the alluvial belt of Gangetic plain of central Uttar Pradesh. The experimental field was homogenous in fertility, well levelled, and had good irrigation and drainage facilities.

3.4 Characteristics of Soil

In order to determine the physico-chemical characteristics of the soil and its fertility status surface soil samples (0-15 cm) were collected randomly from selected places of the experimental field with the help of core and screw auger and analyzed for different physical and physico- chemical properties by adopting standard methods. The results of determined mechanical and chemical properties have been presented in Table 1

Table 1: Mechanical and physico-chemical analyses of soil of the experimental field

Soil Parameter	Initial value	Method adopted
Sand (%)	56.25	Hydrometer method (**Bouyoucos,1962)**
Silt (%)	28.83	
Clay (%)	14.92	
Textural class	Sandy Loam	USDA triangular diagram **(Brady, 1996)**

Soil pH (1:2.5 soil: water) suspension	7.7	pH meter **(Jackson,1973)**
EC (dS m-1 at 25 0C) (1:2.5 Soil: Water)	0.34	EC meter **(Bower and Wilcox,1965)**
Organic carbon (g kg^{-1})	4.1	Walkley and Black method **(1934)** **(Jackson, 1973)**
Available nitrogen (kg ha^{-1})	176	Alkaline potassium permanganate method **(Subbiah and Asija, 1956)**
Available phosphorus (kg ha^{-1})	15.45	Sodium bicarbonate extractable P **(Olsen *et al.*, 1954)**
Available potassium (kg ha^{-1})	172	1 N NH_4OAc Extraction Method **(Hanway and Heidal, 1952)**
Available Zinc (mg kg^{-1})	0.56	DTPA extraction and estimated on atomic absorption spectrophotometer **(Lindsay and Norvell, 1978)**

3.5: Experimental details

The experiment was laid out in Randomized Block Design (R.B.D.) with fourteen different treatment combinations and three replications. The details of treatment combinations and layout plan are as follow:

Table 2: Treatment Combinations

T_1	Control (Absolute)
T_2	100% NPK
T_3	75% NPK + FYM @ 5 ton/ha
T_4	75% NPK + NPK Consortia
T_5	75% NPK + FYM @ 5 ton /ha + Consortia
T_6	75% NPK + FYM @ 5 ton/ha + Nano zinc
T_7	75% NPK + Consortia + Nano zinc
T_8	75% NPK + FYM @ 5 ton/ha + Consortia + Nano zinc
T_9	50% NPK + FYM @ 5 ton/ha
T_{10}	50% NPK + Consortia
T_{11}	50% NPK + FYM @ 5 ton/ha + Consortia
T_{13}	50% NPK + FYM @ 5 ton/ha + Nano zinc
T_{14}	50% NPK + Consortia + nano zinc

4.Result and Discussion

4.1 Growth Parameters

4.1.1 Plant height

At 30 DAT in 2022, the tallest plant height was 57.2 cm, observed in treatment T8 (75% NPK + FYM @ 5 tons/ha + Consortia + Nano Zinc), which was significantly greater than T1, T2, T4, T5, T9, T10, T13, and T10. In 2023, the maximum height of 58.36 cm recorded in T8 was significantly greater than all treatments, except T7 and T14. On a pooled data basis, the maximum plant height of 57.79 cm in T8 was significantly higher than all treatments except T7 (75% NPK + Consortia + Nano Zinc) and T14 (50% NPK + FYM @ 5 tons/ha + Consortia + Nano Zinc).

At 60 DAT, during the panicle initiation stage, the maximum plant heights were 83.30 cm in 2022 and 86.28 cm in 2023, both observed in T8 (75% NPK + FYM @ 5 tons/ha + Consortia + Nano Zinc). These heights were significantly greater than all other treatments, except one. The minimum plant height was recorded in the control treatment. On a pooled data basis, the tallest plants (84.79 cm) were recorded in T8, while the shortest plants were observed in the control treatment (T1).

At 90 DAT, the maximum plant heights were 94.15 cm in 2022 and 96.39 cm in 2023, both recorded in T8. These were significantly greater than all other treatments, except T7 (75% NPK + Consortia + Nano Zinc) and T14 (50% NPK + FYM @ 5 tons/ha + Consortia + Nano Zinc) for both years. On a pooled data basis, the maximum height in T8 was 95.27 cm, while the minimum height of 71.23 cm was observed in the control, with T7 and T14 being statistically similar to T8.

At harvest, the maximum plant heights of 96.09 cm in 2022 and 98.08 cm in 2023 were recorded in T8, significantly higher than all other treatments except T7 and T14. The shortest plant heights at harvest were 75.05 cm in 2022 and 76.61 cm in 2023, observed in the control. On a pooled basis, T8 recorded the maximum plant height of 97.09 cm, significantly higher than all other treatments except T14, while the minimum height of 75.83 cm was recorded in the control (T1).**Sharma *et al.*, (2018)**

4.1.2 Plant population

The data presented in Table 3 revealed that the highest plant population was recorded in treatment T7 (75% NPK + Consortia + Nano Zinc), with 49.30 plants per square meter in 2018-19 and 50.72 plants per square meter in 2019-20. This was statistically on par with treatment T6 (75% NPK + FYM @ 5 ton/ha + Nano zinc) but significantly superior to the other treatments. All treatments, except the control, showed a significantly higher plant population compared to the control plot in both years of the study. The lowest plant population was consistently observed in the control plot. While the incorporation of micronutrients like nano zinc and biofertilizers (alone or in combination) did influence plant population, the increase was not statistically significant during either year**.**Similar finding was reported by**Revathi *et al.* (2014)**

4.1. Dry matter accumulation (gm^{-2})

The data on dry matter accumulation per square meter, as influenced by various treatments, are summarized in Table 4. At the harvest stage, significant differences in dry matter accumulation were observed across the treatments. The data show that dry matter accumulation varied between 2022 and 2023. The highest dry matter accumulation was recorded in treatment T_8 (75% NPK + Consortia + FYM @ 5 tons/ha + Nano Zinc), while the control had the lowest. Based on pooled data, treatment T_8 showed significantly higher dry matter accumulation, followed by T_6 (75% NPK + FYM @ 5 tons/ha + Nano Zinc).Similar findings were reported by**Apon *et al.* (2018) and Urmi *et al.,* (2022)**

4.2 Yield and yield attributes

4.2.1 Effective tillers (m^{-2})

A review of the data in Table 5 revealed that the number of effective tillers per square meter varied significantly. In the first year, the control treatment had an average of 127.17 to 130.91 effective tillers, while in the second year, treatment T_8 (75% NPK + Consortia + FYM @ 5 tons/ha + Nano Zinc) recorded the highest number, ranging from 178.25 to 184.14 tillers. On a pooled basis, the maximum number of tillers (181.20) was observed in T_8, significantly higher than all other treatments.Similar findingwas reported by**Kumar *et al.* (2023)**

4.2.3 Number of grains per panicle

The data presented in Table 5 indicate that the number of grains per ear was significantly influenced by nutrient applications in the rice crop during both years of the study. In the first year, the number of grains per ear ranged from 58.20 to 85.23, while in the second year it varied between 60.39 and 89.65. The highest number of grains per ear in the first year was recorded in treatment T8 (75% NPK + Consortia + FYM @ 5 tons/ha + Nano Zinc) with 85.23 grains, followed by treatments T_{14} (50% NPK + Consortia + FYM @ 5 tons/ha + Nano Zinc) and T_7. The lowest value, 58.20 grains, was observed in the control treatment in 2022. In the second year, the highest number of grains per panicle was again recorded in T8 with 89.65 grains, while the lowest, 60.39 grains, was found in the control plot.

The application of T_8 (75% NPK + Consortia + FYM @ 5 tons/ha + Nano Zinc) consistently resulted in a higher number of grains per ear compared to other nutrient treatments. On a pooled data basis, T8 recorded the maximum number of grains per ear (87.44), while the control had the minimum (59.29). All nutrient treatments produced significantly more grains per panicle compared to the control in both years of the study.Similar finding was reported by**Parmar*et al.* (2022)**

4.2.4 Test weight (g)

Test weight known as 1000 grain weight as influenced by different treatment are presented in table 5. It is clear from the table that the test weight did not differ significantly under different treatment and ranged from 28.64 to 25.54 and 29.50 to 26.11 during both the year. Similar finding was reported by**Sharma *et al.* (2023)**

4.2.5 Grain yield (q ha^{-1})

The data presented in Table 5 indicate that all treatments significantly increased grain yield compared to the control. The highest grain yields, 40.13 q ha^{-1} in the first year and 44.12 q ha^{-1} in the second year, were recorded with treatment T8 (75% NPK + Consortia + FYM @ 5 tons/ha + Nano Zinc). The control plot (T_1) produced the lowest yields, with 18.29 q ha^{-1} in the first year and 20.66 q ha^{-1} in the second year. On a pooled data basis, the maximum grain yield was 43.6 q ha^{-1}, followed by 41.85 q ha^{-1} in T_{14} (50% NPK + Consortia + FYM @ 5 tons/ha + Nano Zinc), with the lowest yield of 19.79 q ha^{-1} recorded in the control.Similar findings were reported by**Senthilvalavan& Ravichandran (2015)and Nandy *et al.,* (2023)**

4.2.6 Straw yield (q ha^{-1})

The data in Table 6 show that straw yield was significantly affected by nutrient applications in both years of the study. In the first year, straw yield ranged from 41.84 to 73.41 q ha^{-1}, while in the second year it varied from 44.15 to 79.11 q ha^{-1}. The highest straw yield was recorded in T8 (75% NPK + Consortia + FYM @ 5 tons/ha + Nano Zinc), with 73.41 q ha^{-1} in the first year and 79.11 q ha^{-1} in the second year, followed by T_{14} (50% NPK + Consortia + FYM @ 5 tons/ha + Nano Zinc). The control plot produced the lowest straw yields, 41.84 q ha^{-1} in 2022 and 44.15 q ha^{-1} in 2023. Based on pooled data, the maximum straw yield was 76.26 q ha^{-1} in T8, while the minimum was 43.00 q ha^{-1} in the control.Similar findings were reported by**Subehia and Sepehya (2012) and Ram *et al.,* (2020)**

4.2.7 Biological yield (q ha^{-1})

The data in Table 6 demonstrate that the biological yield of hybrid rice increased significantly across all treatments compared to the control in both years. The highest biological yields were recorded in T_8 (75% NPK + Consortia + FYM @ 5 tons/ha + Nano Zinc), with 116.95 q ha^{-1} in the first year and 127.83 q ha^{-1} in the second year, followed by T_{14}, which recorded 107.01 q ha^{-1} and 117.84 q ha^{-1}, respectively. The lowest biological yields were observed in the control (T_1), with 60.67 q ha^{-1} in the first year and 64.84 q ha^{-1} in the second year. On a pooled data basis, the maximum biological yield was 122.39 q ha^{-1} in T8, while the control produced the minimum of 62.78 q ha^{-1}, with alltreatments showing significantly higher values than the control.Similar findings were reported by**Zaidi and Tripathi (2007) andThakur*et al.*(2020)**

Conclusion

The study demonstrated that the integration of nano zinc, organic manure (FYM), and microbial consortia with reduced doses of NPK fertilizers significantly enhanced the growth, yield, and soil quality of rice. Treatment T_8 (75% NPK + FYM @ 5 tons/ha + Consortia + Nano Zinc) consistently showed superior results across all measured parameters, including plant height, dry matter accumulation, number of effective tillers, grains per panicle, grain yield, straw yield, and biological yield. The application of T_8 resulted in the highest grain yield (43.6 q/ha), biological yield (122.39 q/ha), and plant height (97.09 cm at harvest), making it a highly effective and profitable nutrient management strategy.

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Table-3: Effect of Nano Zinc and Consortiaon plant height at different growth stages of rice

Treatment Symbol	Treatment Combination	Plant height (cm) at 30 DAT			Plant height (cm) at 60 DAT			Plant height (cm) at 90 DAT			Plant height (cm) at Harvest DAT		
		2021-22	2022-23	Pooled	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled
T_1	**Control (Absolute)**	46.49	47.42	46.96	64.96	67.28	66.12	70.39	72.06	71.23	75.05	76.61	75.83
T_2	**100% NPK**	48.57	49.54	49.06	68.46	70.91	69.68	74.95	76.73	75.84	79.07	80.71	79.89
T_3	**75% NPK + FYM @ 5 ton/ha**	50.63	51.65	51.14	71.87	74.44	73.15	79.60	81.49	80.55	83.10	84.82	83.96
T_4	**75% NPK + NPK Consortia**	51.45	52.48	51.97	73.24	75.86	74.55	81.35	83.29	82.32	84.61	86.37	85.49
T_5	**75% NPK + FYM @ 5 ton /ha + Consortia**	53.51	54.58	54.05	76.85	79.60	78.22	86.00	88.05	87.02	88.84	90.68	89.76
T_6	**75% NPK + FYM @ 5 ton/ha + Nano zinc**	54.33	55.42	54.88	78.22	81.02	79.62	87.75	89.84	88.79	90.35	92.23	91.29
T_7	**75% NPK + Consortia + Nano zinc**	55.57	56.68	56.13	80.56	83.44	82.00	90.65	92.81	91.73	92.97	94.90	93.93
T_8	**75% NPK + FYM @ 5 ton/ha + Consortia + Nano zinc**	57.21	58.36	57.79	83.30	86.28	84.79	94.15	96.39	95.27	96.09	98.08	97.09
T_9	**50% NPK + FYM @ 5 ton/ha**	48.99	49.97	49.48	69.33	71.81	70.57	76.10	77.91	77.00	80.08	81.74	80.91
T_{10}	**50% NPK + Consortia**	49.81	50.81	50.31	70.70	73.23	71.96	77.85	79.70	78.78	81.59	83.28	82.43
T_{11}	**50% NPK + FYM @ 5 ton/ha + Consortia**	52.27	53.32	52.80	74.61	77.28	75.94	83.10	85.08	84.09	86.22	88.01	87.11
T_{12}	**50% NPK + FYM @ 5 ton/ha + Nano zinc**	53.09	54.16	53.62	75.98	78.70	77.34	84.85	86.87	85.86	87.83	89.65	88.74
T_{13}	**50% NPK + Consortia + nano zinc**	54.75	55.85	55.30	79.09	81.92	80.50	88.90	91.01	89.96	91.36	93.26	92.31
T_{14}	**50% NPK + FYM @ 5 ton/ha + Consortia + Nano zinc**	56.39	57.52	56.96	81.93	84.86	83.39	92.40	94.60	93.50	94.48	96.44	95.46
	SEM(+/-)	**0.61**	**0.65**	**0.45**	**1.02**	**1.09**	**0.75**	**1.30**	**1.37**	**0.94**	**1.08**	**1.33**	**0.78**
	C.D.at 5% of level	**1.77**	**1.89**	**1.26**	**2.97**	**3.17**	**2.12**	**3.77**	**3.99**	**2.68**	**3.15**	**3.28**	**2.22**

Treatment Symbol	Treatment Combination	Plant Population (plant/m^2)			Dry matter accumulation (g/m^2)		
		2021-22	2022-23	Pooled	2021-22	2022-23	Pooled
T_1	**Control (Absolute)**	34.00	34.71	34.35	34.00	34.71	34.35
T_2	**100% NPK**	34.43	35.15	34.79	34.43	35.15	34.79
T_3	**75% NPK + FYM @ 5 ton/ha**	34.85	35.57	35.21	34.85	35.57	35.21
T_4	**75% NPK + NPK Consortia**	34.99	35.72	35.35	34.99	35.72	35.35
T_5	**75% NPK + FYM @ 5 ton /ha + Consortia**	35.41	36.15	35.78	35.41	36.15	35.78
T_6	**75% NPK + FYM @ 5 ton/ha + Nano zinc**	35.55	36.29	35.92	35.55	36.29	35.92
T_7	**75% NPK + Consortia + Nano zinc**	35.83	36.58	36.20	35.83	36.58	36.20
T_8	**75% NPK + FYM @ 5 ton/ha + Consortia + Nano zinc**	36.11	36.86	36.49	36.11	36.86	36.49
T_9	**50% NPK + FYM @ 5 ton/ha**	34.57	35.29	34.93	34.57	35.29	34.93
T_{10}	**50% NPK + Consortia**	34.71	35.43	35.07	34.71	35.43	35.07
T_{11}	**50% NPK + FYM @ 5 ton/ha + Consortia**	35.13	35.86	35.50	35.13	35.86	35.50
T_{12}	**50% NPK + FYM @ 5 ton/ha + Nano zinc**	35.27	36.00	35.64	35.27	36.00	35.64
T_{13}	**50% NPK + Consortia + nano zinc**	35.69	36.43	36.06	35.69	36.43	36.06
T_{14}	**50% NPK + FYM @ 5 ton/ha + Consortia + Nano zinc**	35.97	36.72	36.34	35.97	36.72	36.34
	SEM(+/-)	**0.71**	**0.79**	**0.53**	**0.71**	**0.79**	**0.53**
	C.D.at 5% of level	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

Table-4: Effect of Nano Zinc and Consortiaon plant population and dry matter accumulation

Treatment Symbol	**Treatment Combination**	**Number of effective tillers/ m^2**			**Number of grain per panicle**			**Test weight (g)**		
		2021-22	**2022-23**	**Pooled**	**2021-22**	**2022-**	**Pooled**	**2021-22**	**2022-23**	**Pooled**

						23				
Treatment Symbol	**Treatment Combination**	**Grain yield (q/ha)**			**Straw yield (q/ha)**			**Biological yield (q/ha)**		
T_1	**Control (Absolute)**	127.19	130.91	129.05	58.20	60.39	59.29	25.54	26.11	25.83
T_2	**100% NPK**	138.95	143.65	141.30	64.92	68.41	66.67	26.19	27.04	26.62
T_3	**75% NPK + FYM @ 5 ton/ha**	146.80	151.76	149.28	69.65	73.40	71.52	26.69	27.57	27.13
T_4	**75% NPK + NPK Consortia**	149.85	154.92	152.38	70.57	74.37	72.47	26.89	27.79	27.34
T_5	**75% NPK + FYM @ 5 ton /ha + Consortia**	158.80	164.17	161.49	74.53	78.54	76.54	27.39	28.32	27.85
T_6	**75% NPK + FYM @ 5 ton/ha + Nano zinc**	162.05	167.53	164.79	75.45	79.51	77.48	27.59	28.54	28.06
T_7	**75% NPK + Consortia + Nano zinc**	165.75	171.42	168.59	77.49	81.71	79.60	27.76	28.86	28.31
T_8	**75% NPK + FYM @ 5 ton/ha + Consortia + Nano zinc**	178.25	184.14	181.20	85.23	89.65	87.44	28.64	29.50	29.07
T_9	**50% NPK + FYM @ 5 ton/ha**	141.40	146.18	143.79	65.84	69.38	67.61	26.29	27.14	26.72
T_{10}	**50% NPK + Consortia**	144.55	149.44	147.00	67.73	71.37	69.55	26.49	27.36	26.92
T_{11}	**50% NPK + FYM @ 5 ton/ha + Consortia**	153.10	158.28	155.69	71.49	75.34	73.41	27.09	28.00	27.55
T_{12}	**50% NPK + FYM @ 5 ton/ha + Nano zinc**	156.35	161.64	158.99	73.41	77.36	75.39	27.29	28.22	27.76
T_{13}	**50% NPK + Consortia + nano zinc**	164.50	170.06	167.28	76.57	80.69	78.63	27.68	28.64	28.16
T_{14}	**50% NPK + FYM @ 5 ton/ha + Consortia + Nano zinc**	171.94	177.78	174.86	81.41	85.74	83.57	28.09	29.08	28.58
	SEM(+/-)	**1.96**	**2.12**	**1.44**	**1.32**	**1.42**	**0.97**	**0.14**	**0.15**	**0.10**
	C.D.at 5% of level	**5.71**	**6.16**	**4.10**	**3.85**	**4.13**	**2.75**	**0.41**	**0.43**	**0.29**

Table-5: Effect of Nano Zinc and Consortiaon yield attributes of rice

		2021-22	2022-23	Pooled	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled
T_1	**Control (Absolute)**	18.92	20.66	19.79	41.84	44.15	43.00	60.76	64.80	62.78
T_2	**100% NPK**	23.64	26.60	25.12	49.55	53.81	51.68	73.19	80.41	76.80
T_3	**75% NPK + FYM @ 5 ton/ha**	27.31	30.74	29.02	54.24	58.92	56.58	81.55	89.65	85.60
T_4	**75% NPK + NPK Consortia**	28.46	32.04	30.25	55.37	60.14	57.76	83.82	92.18	88.00
T_5	**75% NPK + FYM @ 5 ton /ha + Consortia**	32.44	36.55	34.49	59.90	65.08	62.49	92.34	101.62	96.98
T_6	**75% NPK + FYM @ 5 ton/ha + Nano zinc**	33.76	38.05	35.90	61.10	66.37	63.74	94.85	104.42	99.64
T_7	**75% NPK + Consortia + Nano zinc**	35.68	40.46	38.07	62.59	68.38	65.49	98.27	108.84	103.56
T_8	**75% NPK + FYM @ 5 ton/ha + Consortia + Nano zinc**	40.13	45.12	46.13	71.41	77.11	74.26	116.95	127.83	122.39
T_9	**50% NPK + FYM @ 5 ton/ha**	24.49	27.55	26.02	50.71	55.08	52.90	75.21	82.63	78.92
T_{10}	**50% NPK + Consortia**	25.95	29.20	27.58	52.63	57.16	54.89	78.58	86.36	82.47
T_{11}	**50% NPK + FYM @ 5 ton/ha + Consortia**	29.67	33.42	31.55	56.57	61.45	59.01	86.24	94.87	90.55
T_{12}	**50% NPK + FYM @ 5 ton/ha + Nano zinc**	31.35	35.32	33.33	58.56	63.61	61.08	89.90	98.93	94.42
T_{13}	**50% NPK + Consortia + nano zinc**	34.90	39.34	37.12	62.45	67.84	65.15	97.35	107.18	102.26
T_{14}	**50% NPK + FYM @ 5 ton/ha + Consortia + Nano zinc**	38.34	43.36	39.85	67.66	73.48	70.57	107.01	117.84	112.43
	SEM(+/-)	**1.12**	**1.30**	**0.86**	**1.30**	**1.40**	**0.96**	**2.42**	**2.70**	**1.81**
	C.D.at 5% of level	**3.25**	**3.77**	**2.43**	**3.79**	**4.08**	**2.72**	**7.03**	**7.84**	**5.14**

Table-6: Effect of Nano Zinc and Consortiaon yield of rice