EFFECT OF NANO NITROGEN AND ZINC APPLICATION ON DRY MATTER AT DIFFERENT STAGES AND GRAIN, STRAW YIELD OF PADDY

ABSTRACT

A Pot culture experiment was carried out at Agriculture Research Institute, Rajendranagar, To study the impact of Nano Nitrogen in combination with zinc (soil application or foliar spray) on yield, in paddy crop. The soils employed in net house experiment were selected based on low, medium and high zinc availability classes obtained from the zinc analysis data of surveyed samples. They are low (0.4 mg kg^{-1}), medium (0.71 mg kg^{-1}) and high (1.30 mg kg^{-1}). The results revealed that the highest dry matter at Panicle initiation, Grain and Straw yield were observed in the treatment applied with hundred percent recommended dose of nitrogen through NCU granules along with RDPK and soil application of 25 kg zinc sulphate ha^{-1} resulted in an increase in grain and straw yields by 23 & 24 % over basal application of $1/3^{rd}$ of 100 % RDN through NCU granules along with RDPK coupled with Nano nitrogen sprays (each at MT & PI stages in rice) and soil application of 25 kg zinc sulphate ha^{-1}

Keywords : Nano nitrogen, Dry matter yield, sustainable agriculture, zinc.

INTRODUCTION

Fertilizers have an important role in enhancing food production and nutritional quality especially after the introduction of high-yielding and fertilizer responsive varieties. Most of the major crops grown such as rice, maize, oilseeds, cash crops etc require large quantities of inorganic inputs. 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. Thus, Nano fertilizers are envisioned to have the potential to revolutionize agriculture (Qureshi *et al.*, 2018).

As a result, nitrogen fertiliser application is required to suit the crop's needs. This needs the development of slow-release fertilizers to control nitrification processes and maintain N availability throughout the crop season. Zinc deficiency is common among micronutrient deficiencies in rice, and zinc (Zn) deficiency has been linked to yield reduction in rice alongside N, P, and K. Zinc can be given to crops in a variety of ways, including soil application, foliar spray, seed treatment, and fertigation. Under field conditions, foliar or combination soil + foliar fertilizer application has proven to be highly effective and can be a cost-effective option.

In Telangana's soils, zinc deficiency is widespread (Surendra Babu *et al*, 2015). Zinc sulphate soil application is often indicated for zinc deficient soils. When zinc is not supplied to soils, zinc sprays are indicated to correct deficiency on standing crops.

MATERIAL AND METHODS:

SURVEY : Survey was carried out during summer of 2021- 22 in and around Yadadri Bhuvanagiri districts of Telangana state. Surface soil samples (0-15cm) of were collected from different villages of Motakondur, and Valigonda *mandals* of Yadadri Bhuvanagiri district by following random sampling technique and they were screened for available zinc status in these soils.

The collected soil samples from various locations were air dried under shade. Later dried samples were ground properly by wooden mortar and pestle and then sieved by using 2 mm sieve.

POT CULTURE EXPERIMENT : The present investigation was carried out at Agriculture Research Institute , Rajendranagar which is located at Ranga Reddy District of Telangana State at an altitude of 542.6 m above mean sea level, 78.4237 °E longitude and 17.3142°N latitude. The mean maximum and mean minimum temperatures of the location are 28.0°C to 32.6°C and 10.1°C to 23.9 °C respectively.

ANALYTICAL PROCEDURES: The pH and EC of soil samples were estimated using pH meter and EC meter. The available N, P and K were determined using the alkaline $KMnO_4$ method, Olsen extractable P method and neutral ammonium acetate method respectively. The available zinc, iron, copper and manganese were extracted from soil using DTPA extractant and determined using Atomic Absorption Spectrophotometer (Varian 240 FS AA) as described by Lindsay and Norwell (1978) and expressed in mg kg^{-1}. (Table 1)

NET HOUSE STUDY: The soils employed in net house experiment were selected based on low, medium and high zinc availability classes obtained from the zinc analysis data of surveyed samples. They are low (0.4 mg kg^{-1}), medium (0.71 mg kg^{-1}) and high (1.30 mg kg^{-1}). Bulk soil samples were collected from three different locations with varying levels of available zinc status. These soil samples were air dried, processed and pounded with wooden mortar and pestle and potted in 5 to 6 kg plastic pots with a hole in the bottom

(Table 2). The treatments were fixed at the initiation of the experiment (*kharif 2021-2022*).

RESULTS AND DISCUSSION

The data related to two factors namely treatments and gradients of initial available zinc status and their influence on dry matter production at maximum tillering and panicle stages and yield data at harvest are presented in detail in tables

Maximum tillering stage:

The results of the net house study conducted on effect of Nano nitrogen and zinc application on nitrogen and micronutrient nutrition in rice s in soils varying in available zinc status revealed that there was no significant effect of treatments on the dry matter production at maximum tillering stage and ranged from 3.21 to 3.41 with a mean of 3.28 g pot^{-1} The data regarding the dry matter production at maximum tillering stage is presented in (Table 3).Zinc sulphate application did not influence the dry matter yield at maximum tillering stage.

The plant samples were collected before the second application of nitrogenous fertilizers (either through soil application of Recommeded Dose of Nitrogen as Neem Coated Urea granules or foliar spray of nano Nitrogen or Neem Coated Urea) and foliar spray of zinc sulphate, so the effect remains the same as one third of nitrogenous fertilizer application was through 100 % RDN through NCU as basal. Soil application of zinc sulphate in last puddle before planting in T3, T6 and T9 treatments resulted in an increased dry matter of 0.18 g pot^{-1} over no zinc dry matter production at maximum tillering stage. The increase in dry matter at maximum tillering stage in paddy was 15 percent in medium zinc soil and 29 % in high zinc soil over the low zinc soil. Higher zinc content of the high zinc soil would have resulted in a higher increase in dry matter yield compared to medium zinc soil.

Panicle initiation stage:

The data presented in (Table 4) indicated that dry matter production at panicle initiation stage was significantly influenced by the variation in native soil available zinc status over different urea based treatments. The mean dry matter yield varied from 7.28 to 8.65 g pot^{-1}. Statistically significant effect of different treatments was noticed on the dry matter production at panicle initiate n stage. The data when pooled, soil application of 100 percent NCU granules treatment recorded highest dry matter yield and was higher by 17%

over 1/3 rd of 100 % RDN through NCU as basal + 1 spray of 4% NCU each at MT and PI stages +100% RDPK and was higher by 30% over 1/3 rd of 100 % RDN through NCU as basal + 1 spray of Nano N each at MT and PI stages treatments. The dry matter yield increase was 11 % in NCU (basal + spray) over that of NCU basal + nano spray. Soil application of zinc sulphate added to different urea granule based treatments resulted in an increased yield of 10 percent over no zinc application and 7 % over zinc sprays at panicle initiation stage.

Grain and Straw Yield :

Application of different treatments significantly influenced the paddy grain yield. The paddy grain yield ranged from 26.57 to 26.99 g pot^{-1} with a mean of 25.32 g pot^{-1} (Table 5). And Straw yield ranged from 30.65 to 31.20 with a mean of 29.16 g pot^{-1}.

Among the different urea granule based treatments (T1,T4 and T6) , paddy grain yield differed significantly. it ranged between 21.97 in treatment where 1/3 rd of 100 % RDN was applied through NCU as basal and the remaining two sprays of Nano N each at MT and PI stages and 26.57 g pot^{-1} in the treatment where 100 percent RDN was applied as NCU granules. Foliar spray of 0.2% zinc sulphate did not affect the grain yield significantly but soil application of zinc sulphate significantly increased the yield over no zinc application in different urea granule based treatments. The paddy straw yield was significantly affected by the different urea granule based treatments with out zinc application and it ranged between 25.10 and 30.65 g pot^{-1} (Table 6). Soil application of 25 kg Zn SO_4 ha^{-1} had significantly increased the straw yield over the other two treatments in each set of urea granule based treatments i.e, lone application of NPK treatment and NPK along with zinc spray treatment.

The yields of paddy grain (Tables-5), straw (Table-6) increased significantly due to application of different treatments. Significant variation was noticed between different urea granule based pooled treatments. Paddy grain and straw yields were found to be more in pooled 100% NCU applied as basal over zinc gradients by 22 & 21 and 10 & 9 percent, respectively over pooled NCU + NN and NCU basal + spray treatments. NCU spray when given in combination with NCU basal treatments when pooled resulted in an increased grain and straw yield of 2.51 & 2.85 g pot^{-1}, respectively over pooled treatments of nano N spray in combination with NCU basal

CONCLUSIONS: Application of hundred percent recommended dose of nitrogen through NCU granules along with RDPK and soil application of 25 kg zinc sulphate ha^{-1} resulted in an increase in grain and straw yields by 23 & 24 % over basal application of $1/3^{rd}$ of 100 % RDN through NCU granules along with RDPK coupled with Nano nitrogen sprays (each at MT & PI stages in rice) and soil application of 25 kg zinc sulphate ha^{-1}.

Table 1 Salient characteristics of soils used for pot culture experiment

S.No.	Parameter	Low	Medium	High
1	pH	7.6	8.1	7.4
2	EC (dS m^{-1})	0.55	0.74	0.66
3	OC (g kg^{-1})	6.3	5.6	5.9
4	Nitrogen (kg N ha^{-1})	145	172	210
5	Phosphorus (kg P_2O_5 ha^{-1})	52	47	45
6	Potassium (kg K_2O ha^{-1})	303	342	324
7	Zinc (mg kg^{-1})	0.4	0.71	1.30
8	Copper (mg kg^{-1})	0.61	0.43	0.51
9	Iron (mg kg^{-1})	10.68	11.62	7.1
10	Manganese (mg kg^{-1})	9.87	8.2	12.3

Table 2. The details of treatments are :

S. No	Treatment Details (Urea Granule Based)	T. No	Treatment Details (Urea Granule + Nano N Spray Based)	T. No	Treatment Details (Urea Spray Based)

T1	100 % RDN as NCU granules (3 splits) +100 % RDPK	T4	1/3 rd of 100 % RDN through NCU as basal + 1 spray of Nano N at MT + 1 spray of Nano N at PI (Nano N @ 2.5 bottles/ ha) * +100% RDPK	T7	1/3 rd of 100 % RDN through NCU as basal + 1 spray of 4% NCU at MT +1 spray of 4% NCU at PI +100% RDPK
T2	T1 + 0.2 % Zn SO_4 Spray at MT and at PI	T5	T4+ 0.2 % Zn SO_4 Spray at MT and at PI	T8	T7+ 0.2 % Zn SO_4 Spray at MT and at PI
T3	T1 + Soil application of 25 kg Zn SO_4 ha^{-1} (for one season)	T6	T4 + Soil application of 25 kg Zn SO_4 ha^{-1} (for one season)	T9	T7 + Soil application of 25 kg Zn SO_4 ha^{-1}(for one season)

RDN : Recommended dose of Nitrogen, NCU : Neem coated urea , MT : Maximum tillering stage , PI : Panicle initation

Table 3. Effect of different treatments on dry matter production (g pot^{-1}) in paddy at maximum tillering stage

T. No	Treatmental Details	Zinc Gradients			Mean
		Low	Medium	High	
T1	100 % RDN as NCU granules + 100 % RDPK	2.80	3.30	3.54	3.21
T2	T1+ 0.2 % Zn SO_4 Spray at MT and PI stages	2.78	3.32	3.61	3.24
T3	T1+ Soil application of 25 kg Zn SO_4 ha^{-1}	2.89	3.53	3.71	3.38
T4	1/3 rd of 100 % RDN through NCU as basal + 1 spray of Nano N each at MT and PI stages	2.84	3.11	3.52	3.16
T5	T4+0.2 % Zn SO_4 Spray at MT and PI stages	2.89	3.15	3.55	3.20
T6	T4+ Soil application of 25 kg Zn SO_4 ha^{-1}	2.98	3.37	3.77	3.37
T7	1/3 rd of 100 % RDN through NCU as basal + 1 spray of 4% NCU each at MT and PI stages +100% RDPK	2.76	3.21	3.80	3.26
T8	T7+0.2 % Zn SO_4 Spray at MT and PI stages	2.83	3.24	3.81	3.29
T9	T7+ Soil application of 25 kg Zn SO_4 ha^{-1}	2.92	3.41	3.91	3.41
Mean		2.85	3.29	3.69	3.28
		T	G	TXG	
Sem		0.15	0.04	0.20	
CD (P=0.05)		NS	0.10	0.41	

Table 4. Effect of different treatments on dry matter production (g pot^{1}) in paddy at panic initiation stage

T. No	Treatmental Details	Zinc Gradients			Mean
		Low	Medium	High	
T1	100 % RDN as NCU granules + 100 % RDPK	7.25	8.96	10.12	8.78
T2	T1+ 0.2 % Zn SO_4 Spray at MT and PI stages	7.69	9.13	10.38	9.07
T3	T1+ Soil application of 25 kg Zn SO_4 ha^{-1}	8.29	9.86	11.21	9.79
T4	1/3 rd of 100 % RDN through NCU as basal + 1 spray of Nano N each at MT and PI stages	6.60	6.74	6.97	6.77
T5	T4+0.2 % Zn SO_4 Spray at MT and PI stages	6.77	7.52	6.66	6.98
T6	T4+ Soil application of 25 kg Zn SO_4 ha^{-1}	7.75	7.40	7.23	7.46
T7	1/3 rd of 100 % RDN through NCU as basal + 1 spray of 4% NCU each at MT and PI stages +100% RDPK	6.90	7.74	7.93	7.52
T8	T7+0.2 % Zn SO_4 Spray at MT and PI stages	6.98	8.15	8.40	7.84
T9	T7+ Soil application of 25 kg Zn SO_4 ha^{-1}	7.26	8.42	8.99	8.22
	Mean	7.28	8.21	8.65	8.05

	T	G	TXG
Sem	0.36	0.12	0.47
CD (P=0.05)	0.74	0.25	0.99

Table 5. Effect of different treatments on paddy grain yield (g pot^{-1})

T. No	Treatmental Details	Zinc Gradients			Mean
		Low	Medium	High	
T1	100 % RDN as NCU granules + 100 % RDPK	22.27	26.69	30.77	26.57
T2	T1+ 0.2 % Zn SO_4 Spray at MT and PI stages	23.37	27.30	31.25	27.31
T3	T1+ Soil application of 25 kg Zn SO_4 ha^{-1}	26.18	29.59	33.30	29.69
T4	1/3 rd of 100 % RDN through NCU as basal + 1 spray of Nano N each at MT and PI stages	19.05	22.74	24.12	21.97
T5	T4+0.2 % Zn SO_4 Spray at MT and PI stages	18.94	21.89	25.41	22.08
T6	T4+ Soil application of 25 kg Zn SO_4 ha^{-1}	21.55	23.33	28.22	24.37
T7	1/3 rd of 100 % RDN through NCU as basal + 1 spray of 4% NCU each at MT and PI stages +100% RDPK	21.84	23.97	27.02	24.28
T8	T7+0.2 % Zn SO_4 Spray at MT and PI stages	21.98	23.08	28.94	24.67
T9	T7+ Soil application of 25 kg Zn SO_4 ha^{-1}	24.15	27.24	29.57	26.99

Mean	22.15	25.09	28.73	25.32
	T	G	TXG	
Sem	1.14	0.37	1.52	
CD (P=0.05)	2.28	0.76	3.04	

Table 6. Effect of different treatments on paddy straw yield (g pot^{-1})

T. No	Treatmental Details	Zinc Gradients			Mean
		Low	Medium	High	
T1	100 % RDN as NCU granules + 100 % RDPK	26.45	29.92	35.57	30.65
T2	T1+ 0.2 % Zn SO_4 Spray at MT and PI stages	27.06	30.46	36.06	31.19
T3	T1+ Soil application of 25 kg Zn SO_4 ha^{-1}	30.12	32.78	38.79	33.89
T4	1/3 rd of 100 % RDN through NCU as basal + 1 spray of Nano N each at MT and PI stages	22.05	25.34	27.91	25.10
T5	T4+0.2 % Zn SO_4 Spray at MT and PI stages	22.69	25.86	28.19	25.58
T6	T4+ Soil application of 25 kg Zn SO_4 ha^{-1}	25.30	28.98	31.18	28.49
T7	1/3 rd of 100 % RDN through NCU as basal + 1 spray of 4% NCU each at MT and PI stages +100% RDPK	25.05	27.68	31.12	27.95
T8	T7+0.2 % Zn SO_4 Spray at MT and PI stages	25.67	28.05	31.84	28.52
T9	T7+ Soil application of 25 kg Zn SO_4 ha^{-1}	28.74	30.91	34.12	31.26
	Mean	25.90	28.89	32.75	29.18
		T	G	TXG	
	Sem	1.33	0.44	1.77	
	CD (P=0.05)	2.66	0.89	3.55	

REFERENCES:

1. Ahmed, R., Zia-ur-Rehman, M., Sabir, M., Usman, M., Rizwan, M., Ahmad, Z., Alharby, H.F., Al-Zahrani, H.S., Alsamadany, H., Aldhebiani, A.Y. and Alzahrani, Y.M., 2023. Differential response of nano zinc sulphate with other conventional

sources of Zn in mitigating salinity stress in rice grown on saline-sodic soil. *Chemosphere*,138479.
2. Apoorva, M.R., Rao, P.C., Padmaja, G and Reddy, R.S. 2016. Effect of various sources of zinc with particular reference to nano zinc carrier on growth and yield of rice (*Oryza sativa*). *Journal of Research PJTSAU.* 44(1): 126-129.
3. Archana, K., Satyavikas, G and Dhaliwal, M. 2015. Studies on nano particle induced nutrient use efficiency of fertilizer and crop productivity. *Green Chemistry and Technology Letters.* 2: 88-92.
4. Benzon, H.R.L., Rubenecia, M.R.U., Ultra, V.U and Lee, S.C. 2015. Nano-fertilizer affects the growth, development, and chemical properties of rice. *International Journal of Agronomy and Agricultural Research*. 7(1): 105-117.
5. Cakmak, I. 2008. Enrichment of cereal grains with zinc: agronomic or genetic biofortification? *Plant and soil*. 302(1):1-17.
6. Dhage, S. and Biradar, D.P. 2020. Nanofertilizers: Perspective to Enhance Growth, Yield and NUE of Crops. *Indian Journal Pure and Applied Biosci*ences. 8(6): 339-349.
7. Kumar, R., Rathore, D.K., Singh, M., Kumar, P. and Khippal, A., 2016. Effect of phosphorus and zinc nutrition on growth and yield of fodder cowpea. *Legume Research-An International Journal*, *39*(2).262-267.
8. Kumari, K., 2017. Yield, quality and nutrient uptake of rabi fodder crops in response to zinc. *Annals of Plant and Soil Research*. *19*(2): 219-222.
9. Lahari, S., Hussain, S.A., Parameswari, Y.S and Sharma, K.H.S. 2021. Grain yield and nutrient uptake of rice as influenced by the nano forms of nitrogen and zinc. *International Journal of Environment and Climate Change*. 11(7): 1-6.
10. Lindsay, W.L and Norvell, W.A. 1978. Development of a DTPA soil test for Zinc, Iron, Manganese and Copper. *Soil Science Society of America Journal*. 42(3): 421-428.
11. Liscano, J.F., Wilson, C.E., Norman. R.J and Slaton, N.A. 2000. Zinc availability to rice from seven granular fertilizers. *AAES Research Bulletin*. 963: 1–31.
12. Mehta, S. and Bharat, R. 2019. Effect of integrated use of nano and non-nano fertilizers *Journal of Current Microbial and Applied Sciences*. 8(12): 598-606.
13. Midde, S.K., Perumal, M.S., Murugan, G., Sudhagar, R., Mattepally, V.S and Bada, M.R. 2022. Evaluation of nano urea on growth and yield attributes of rice. *Chemical Science Review Letters.* 11(2): 211-214.
14. Panse, V.G and Sukhatme, P.V. 1978. Statistical methods for agricultural works, Indian Council of Agricultural Research. New Delhi. 361.
15. Prasad, T.N.V.K.V., Sudhakar, P., Sreenivasulu, Y., Latha, P., Munaswamy, V., Reddy, K.R., Sreeprasad, T.S., Sajanlal, P.R and Pradeep, T. 2012. Effect of nanoscale zinc oxide particles on the germination, growth and yield of peanut. *Journal of Plant Nutrition*. 35(6): 905-927.
16. Rathnayaka R.M.N.N., Mahendran S., Iqbal Y.B and Rifnas L.M. 2018..Influence of urea and Nano-nitrogen fertilizers on the growth and yield of rice (*Oryza sativa* L.) cultivar Bg250.*International journal of research publication*, 5(2).
17. Reddy V.G, Rabindra Kumar, Yasin Abrar Baba, Maddila Teja and Thimmisetty Raviteja (2019). Response of nitrogen and zinc on growth and yield of *kharif* maize (*Zea mays* L.). Journal of Pharmacognosy and Phytochemistry 2019. 8(4): 385-387.
18. Surendra Babu, P., Patnaik, M. C. and Shankaraiah. M (2015), Annual Report of AICRP on Micro & Secondary Nutrients and Pollutant Elements in Soils and Plants, PJTSAU, Hyderabad.

19. Vasundhara, D. and Chhabra, V., 2021. Foliar nutrition in cereals: A review. *Pharma Innovation*. *10*:1247-1254.