Original Research Article

EFFECT OF NANO NITROGEN AND ZINC APPLICATION ON DRY MATTER 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 (T_3- Soil application of 25 kg Zn SO_4 ha^{-1} and 100 % Recommended dose of Nitrogen was applied as Neem coated urea granules).

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

INTRODUCTION

Fertilizers have been increasingly significant in improving food production and nutritional quality, particularly since the development of high-yielding, fertilizer-responsive cultivars. Rice, maize, oilseeds, cash crops, and other significant crops all require large amounts of inorganic inputs. Researchers have been undertaking a variety of trials using various methods to boost agricultural production and productivity. As a result, agricultural researchers strive to develop sustainable agriculture with higher yields while keeping a pollution-free environment. Chemical fertilisers have long been condemned for their negative effects on the environment and the quality of agricultural products, and scientists are exploring for better alternatives.

The majority of rice soils are nitrogen deficient, and biological nitrogen fixation by Cyanobacteria diaztrophic bacteria can only meet a part of the N requirement. As a result, nitrogen fertiliser application is required to suit the crop's needs. This needs the development of slow-release fertilisers to control nitrification processes and maintain N availability throughout the crop season. In the recent past, just a few have been documented in the literature involving Nanomaterials. These Nano fertilisers provide for a slow and consistent delivery of nutrients, reducing nutrient loss and increasing nutrient efficiency.

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. According to the producers, Nano N is noted for its compatibility. However, the impact of Nano N in combination with zinc soil application or foliar spray on yield in agricultural output is unknown.

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:

Effect of different treatments: The data regarding the dry matter production at maximum tillering stage is presented in table . There is no significant effect of treatments on the dry matter production at maximum tillering stage . The dry matter production ranged from 3.21 to 1.67 with a mean of 1.66 g pot^{-1} (Table 3). Zinc sulphate application did not influence the dry matter yield at maximum tillering stage.

There was no significant difference due to different urea granule based treatments (T1,T4 and T6) on the dry matter produced at maximum tillering stage and it ranged between 3.16 and 3.26 g pot^{-1} (Table). Zinc application either through soil or foliar along with the urea based granule treatments also did not result in any significant difference on the dry matter production at maximum tillering stage.

Effect of zinc gradients: The data presented in table indicated that dry matter production at maximum tillering stage was significantly influenced by the variation in native soil available zinc status over different urea based treatments. The dry matter yield varied from 2.85 to 3.69 with a mean of 3.28 g pot^{-1}.

Interaction of treatments X Zn gradients: The interaction of treatments X Zn gradients on dry matter yield was found to be statistically significant.

Panicle initiation stage:

Effect of different treatments: The data regarding the dry matter production at panicle initiation stage is presented in table . Statistically significant effect of different treatments was noticed on the dry matter production at panicle initiation stage. It varied between 6.77

and 9.79 with a mean of 8.05 g pot^{-1} (Table 4).

The dry matter production due to different urea granule based treatments alone (with out zinc application) at panicle initiation stage ranged between 6.77 and 8.78 g pot^{-1} (Table) and was statistically significant. Soil application of 25 kg Zn SO_4 ha^{-1} had significantly increased the dry matter yield at panicle initiation stage only in the treatment where 100 % RDN was applied as NCU granules .

Effect of zinc gradients: The data presented in table 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}.

Interaction of treatments X Zn gradients: The interaction of treatments X Zn gradients on dry matter yield was found to be statistically significant at panicle initiation stage.

Grain Yield:

Effect of different treatments: 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).

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.(Table). 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.

Effect of zinc gradients: The data presented in table indicated that paddy grain yield was significantly influenced by the variation in native soil available zinc status over different urea based treatments. The grain yield varied from 22.15 to 28.73 with a mean of 25.32 g pot^{-1}.

Interaction of treatments X Zn gradients: The interaction of treatments X Zn gradients on paddy grain yield was found to be statistically significant

Straw yield:

Effect of different treatments:. Statistically significant effect of different treatments was observed on straw yield and the data is presented in tables & . It ranged from 30.65 to 31.20 with a mean of 29.16 g pot^{-1} . 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..

Effect of zinc gradients: The data presented in table indicated that straw yield was significantly influenced by the variation in native soil available zinc status. Highest straw yield of 32.75 g pot^{-1}. was recorded in high Zn soil followed by medium (28.89 g pot^{-1}) and low zinc soils. (25.90g pot^{-1}).

Interaction of treatments X Zn gradients: The interaction of treatments X Zn gradients on paddy straw yield was found to be statistically significant.

CONCLUSIONS : Soil application of 25 kg Zn SO_4 ha^{-1} had significantly increased the dry matter yield at panicle initiation stage, Grain yield and Straw yield only in the treatment where 100 % RDN was applied as NCU granules .

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	

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