J Krishi Vigyan 2021, 9 (2) : 204-208 DOI : 10.5958/2349-4433.2021.00038.6

Soil Application of Zinc Enhanced Growth Parameters in Paddy in North West Himalayas

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ABSTRACT

The experiment was conducted during kharif 2017 and 2018 seasons in five villages of Mandi district of Himachal Pradesh to study the impact of zinc supplementation on growth and yield parameters in paddy. Three treatments were comprised of T_1: Farmer's practice (FP) 12:32:16 (NPK) 100 kg/ha and Urea 100 kg/ha, T_2: FYM @ 20 t/ha + Recommended dose of 100% NPK @ 125:100:60 kg/ha and T_3: T_2+ zinc sulphate @ 25 kg/ha. Farm Yard Manure (FYM) @ 20 t/ha + recommended dose (100 % NPK) along with $ZnSO_4$ @ 25 kg/ha applied at the time of transplanting. The significant increase in growth parameters viz. plant height (111.2 cm), number of tillers (14.30), ear length (27.65 cm) and days of maturity (113.32) was recorded as compared to the control T_1 (103.05 cm, 10.70, 21.85 cm and 110.6). 1000 grain weight, grain yield and straw yield recorded in T_3 were 21.77 g, 45.75 and 56.28 q/ha, respectively. The highest net return and B:C ratio were recorded in T_3 (Rs. 42791/-and 2.26) over the farmers' practice $T_1$with net return of Rs. 29625/- and B:C ratio 1.94 where the zinc was applied. The harvest index and nutrient concentration in soil also recorded the increase during both the years of study. The treatment T_2 also reported the significant improvement over the farmer's practice T_1 in growth and yield parameters, harvest index, zinc content in soil and economics during both the years.

Key Words: growth, harvest index, nutrient content, rice, yield and zinc.

INTRODUCTION

Zinc is responsible for the formation of a large number of enzymes and also plays an essential role in DNA transcription (Dinesh *et al,* 2017; and Black *et al,* 2008). Zinc is important for the plant growth and its deficiency is widely reported in many rice growing regions of the world (Ghoneim, 2016). Next to nitrogen and phosphorus, zinc deficiency is now considered as one of the most widespread nutrient disorder in lowland rice areas in Asia (Quijano Guerta *et al,* 2002). Rice (*Oryza sativa L.*) is grown over about 44 Mha with production of 109 Mt (GOI, 2018). In order to meet the food and nutritional requirement of the people the projected demand of the rice by 2030 to be estimated at 904 Mt of the world and 824 Mt for Asian countries. India alone would require producing about 156 Mt of rice by the year 2030 with the annual increment of 3 Mt in the current rice production (Dinesh *et al,* 2017). Being one of the most important kharif season cereal crops, it is one of the main food for people around the globe residing in the humid tropics and subtropics. Rice among all cereal crops is consumed by about half of the world's population and is an important source of carbohydrates and proteins to some extent to the humans. All over the world cereals are the major source of Zn for the masses, especially among the poor people living in rural areas. This problem is acute for rice consumers as the rice has the lowest Zn content among the cereals (Boonchuay *et al,* 2013).

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Half of the Indian soils are poor in availability of zinc and this deficiency has been associated with a wide range of soil conditions i.e. high pH, low available Zn content, prolonged submergence and low redox potential, high organic matter and bicarbonate content, high magnesium (Mg) to calcium (Ca) ratio, and high available P (Firdous *et al* ,2018).

Zinc deficiency causes many symptoms that usually appear after 2 to 3 wk of transplanting the rice seedlings. Zinc deficiency can be corrected by adding zinc formulations to the soil. Application of zinc fertilizers such as zinc sulphate ($ZnSO_4$) and zinc oxide (ZnO) in the soil increased dry matter, grain yield and grain zinc concentration in rice (Shehu and Jamala, 2010; Fageria *et al,* 2011). Keeping in view of the importance of zinc nutrition and its efficiency in growth and yield of rice, experiment was conducted at the farmers' field in the different villages of the Mandi district of the Himachal Pradesh during *kharif* season.

MATERIALS AND METHODS

The experiments were laid for two consecutive years during *kharif* 2017 and 2018 at five different locations which were considered as replications with three different treatments. The soil samples (Table 1) were taken from the respective locations, analyzed and found pH (6.4 to 7.8), electrical conductivity (0.16 to 0.24 dSm^{-1}) and organic carbon (0.81 to 1.3 %). The available nitrogen was in the range of 138.5 to 179.3, available phosphorous (8.3 to 13.6), available potassium (223.4 to 287.6 kg/ha) and zinc concentration (0.41 to 0.56) at the time of seedling transplantation (Table 1). Three treatments were comprised of T_1: Farmer's practice (FP) 12:32:16 (NPK) 100 kg/ha and Urea 100 kg/ha, T_2: FYM @ 20 t/ha + Recommended dose of 100% NPK @ 125:100:60 kg/ha and T_3: T_2+ zinc sulphate @ 25 kg/ha. The sources of the fertilizer incorporated in soil were urea (46% N), IFFCO (NPK; 12:32:16 %), Muriate of potash (60% K_2O) and zinc sulphate ($ZnSO_4$). Full doses of P and K were applied as basal dose at the time of transplanting. The half dose of N was applied as basal and remaining was applied in two split doses as top dressing. The ZnSO4 was applied at the time of transplanting. The observations with regard to growth parameters and yield and its parameters were recorded from randomly selected 10 plants from each location.

Table 1. Initial soil data of the samples collected.

Parameter	Range
pH	6.5-6.9
Electrical Conductivity (dsm^{-1})	0.17-0.19
Organic Carbon (%)	0.93-1.1
Nitrogen (Kg/ha)	147.5 -168.3
Phosphorous (Kg/ha)	9.0 -12.3
Potassium (Kg/ha)	210.4 - 248.7
Zinc concentration (mg kg^{-1})	0.35-0.39

RESULTS AND DISCUSSION

Growth and yield parameters

The data (Table 2) revealed that significant increase in the treatment $T_3$was reported in which FYM @ 20 t/ha + Recommended dose of 100% NPK @ 125:100:60 kg/ha + zinc sulphate (ZnSO4) @ 25 kg/ha were applied with average plant height of 111.2 cm as compared to the farmer practiceT_1(103.05 cm) with an increase of 8.68 per cent. The treatment T_2 also revealed the increase in the plant height (108.8 cm) over T_1 (103.05 cm) but found to be statistically non significant with T_3 during both the years. The number of tillers per plant in (Table2) in paddy crop reflects the significant enhancement in T_3 (14.30) but non-significant in T_2 comparison to the farmer practice T_1 (10.70). The data also reflected the increase in the average ear length due to the zinc incorporation with recommended 100 % NPK in treatment T_3 (27.65 cm) with the recommended dose of fertilizer as compared to $T_1$with the average ear length to the tune of 21.85 cm. The similar findings have been reported by Khan *et al* (2003) and Dinesh *et al* (2017) which showed that application of zinc increased number of tillers and length of panicle in the paddy crop.

Table 2. Effect of zinc application on growth and yield parameters in the paddy crop .

Treatment	Plant height (cm)	No. of Tillers per plant	Ear Length (cm)	Days of Maturity (No.)	1000 grain weight (g)	Grain Yield (q/ha)	Straw Yield (q/ha)	Percent Increase (%)	Harvest Index (%)
T_1	103.05	10.70	21.85	110.6	19.58	36.32	51.11	-	41.54
T_2	108.8	12.80	24.05	111.7	21.14	41.87	53.45	25.96	43.93
T_3	111.2	14.30	27.65	113.32	21.77	45.75	56.28	15.28	44.84
CD (5%)	3.76	1.56	3.94	0.046	0.08	4.41	3.88	-	-

The increase in number of days of maturity in the paddy crop (Table 2) were recorded in treatment T_3 (114.32) over the treatment T_1 (110.60) farmer's practice. Similarly, the treatment T_2 (111.7) also reported the significant increase in the number of days of maturity over the treatment T_1 (110.60) the farmer practice (Table 2). These findings were in agreement to Rahman *et al* (2008).

The data (Table 2) recorded significant increase in the 1000 grain weight in the treatment T_3 (21.77 g) over the treatment T_1 (19.55 g). The significant enhancement in the grain yield of the paddy crop were recorded with the application of the zinc supplementation in the treatment T_3 (45.75 q/ha) over the farmer practice T_1 with the average yield of 36.32 q/ha during both the years. The percent increase of 25.96 percent was recorded. The grain yield data in the treatment T_2 (41.87 q/ha) showed significant improvement as compared to the farmers practice T_1 but remained at par with the T_3. Similarly, increase in the straw yield was recorded in T_3 (56.28 q/ha) and T_2 (53.45 q/ha) over the treatment T_1 which is farmer's practice (51.11 q/ha). The findings were in conformity with the findings of the (Muamba *et al,* 2013)

The improvement in the harvest index in T_3 (44.84 %) followed by T_2 (43.93 %) was recorded during both the years over the farmer's practice T_1 (41.54 %) which might have been due to better agro-climatic conditions as well as nutrient uptake by crop. The similar findings have been reported by Mohammad and Manoj (2015).

Economics

The soil incorporation of zinc in T_3 treatment resulted in the average net returns of Rs. 42791/- (Table 4) as compared to the farmer's practice$T_1$with the net returns of Rs. 29625/-. The difference of Rs. 13166/- was reported between the net returns obtained in the treatment T_3 and T_1. The application of the recommended dose in the T2 (Rs. 37592/-) was also recorded superior in monetary terms over T_1. The range of the cost of cultivation was revealed from Rs. 31393/- to Rs. 34069/- per hectare and the difference in the cost of cultivation among the treatment T_3 and T_1 is Rs. 2676/-. However, the B: C ratio of 1: 2.26 was recorded with the treatment T_3 (Table 4) as compared to the farmer practice T_1 where the B: C ratio of 1: 1.94 was obtained. The treatment T_2 also showed the B:C ratio of 1: 2.15 over the treatment T_1. The reason for the increase in the net returns might be due to the more yield, fruit weight and fruit size. These results could substantiate the findings of Firdaus *et al* (2008).

Table 3. Effect of zinc application on Net Return and B: C ratio of the paddy crop.

Treatments	Cost of cultivation (Rs)	Net Return (Rs.)	B:C ratio
T_1	31393	29625	1.94
T_2	32750	37592	2.15
T_3	34069	42791	2.26
Average	32737	36669	2.12

Soil Zinc Status

Zinc is present in different chemical forms with varying solubilities in soil such as soluble zinc present in soil solution (water soluble), adsorbed on exchange sites (exchangeable), associated with organic matter, co-precipitated as secondary minerals or associated with sesquioxides. Soil chemical properties such as pH, relative humidity and soil organic matter have strong influence on zinc adsorption-desorption reactions and play a critical role in regulating zinc solubility and its fractionation in soils. The availability of zinc to plants is depends on solubility and availability of the variable zinc forms. The sources of zinc, application time, methods of application and soil chemical properties reflects varied responses in rice to the zinc fertilizers (Ghoneim, 2016). The application of zinc in rice significantly affected the concentration of zinc in soil over the farmer practice that ranged from 0.41 mg/kg to 1.12 mg/kg (Fig 1). The highest concentration was recorded with the application of zinc @ 25 kg/ha with the recommended dose of fertilizer in T3 (1.12 mg/kg) over the farmer's practice T1 (0.41 kg/ha). The application of 100 percent recommended dose of fertilizer also showed the increase in the zinc concentration in T2 (0.46 mg/kg) over the control treatment T1 where minimum concentration of zinc was recorded. Zinc application significantly enhanced yield of rice and available soil zinc content. The results were in agreement with the findings of Rahmatullah *et al* (2007) and Ghoneim (2016).

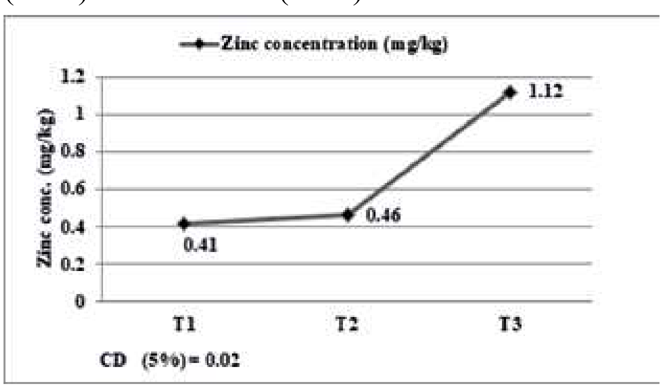

Fig 1: Effect of zinc supplementation on zinc concentration in soil

CONCLUSION

It may be concluded from the results obtained that application of recommended dose (100% NPK) along with Zinc sulphate @ 25 kg/ha improved growth, yield its attributes and harvest index over the farmer's practice in the agro climatic conditions of North Western Himalayas. This treatment was best suited to alleviate the deficiency of zinc in rice and can be recommended among farmers of Mandi district of Himachal Pradesh.

REFERENCES

Black R, Lindsay H, Bhutta Z, Caulfield L and De Onnis M (2008). Maternal and child under- nutrition: Global and regional exposures and health consequences. *Lancet* **371**: 243–260.

Boonchuay Panomwan, Cakmak Ismail, Rerkasem Benjavan and Chanakan Prom U Thai (2013). Effect of different foliar zinc application at different growth stageson seed zinc concentration and its impact on seedling vigor in rice. *Soil Sci and Pl Nutri* **59**: 180–188

Dinesh Kumar, Rajesh Kumar, Prashant Singh and Pushpendra Kumar (2017). Effect of different zinc management practices on growth, yield, protein content, nutrient uptake and economics on rice under partially reclaimed salt-affected soil. *J Pharmacognosy and Phytochem* **6**(5): 638-640

Fageria N K, Dos Santos A B, Cobucci T (2011). Zinc nutrition of lowland rice. *Soil Sci Plant Annal* **42**: 1719–1727.

Firdous S, Agarwal B K, Shahi D K, Bhushan Shashi (2018). The Effect of Zinc Fertilization on Rice Productivity and Economics in Acid Alfisol of Jharkhand, India. *Int J Curr Microbiol App Sci* Special Issue **7**: 2676-2682

Ghoneim A M (2016). Effect of Different Methods of Zn Application on Rice Growth, Yield and Nutrients Dynamics in Plant and Soil. *J Agri and Eco Res Int* **6**(2): 1-9

GOI (2018). Agriculture statistics at a glance. www.agricoop.nic.in & http:// eands.dacnet nic.in

Khan M U, Qasim M, Subhan M, Jamil M and Ahmad R D (2003). Response of Rice to Different Methods of Zinc Application in Calcareous Soil. *J Appl Sci* **3:** 524-529.

Mohammad A A and Manoj Kumar (2015). Effect of Zinc on growth and yield of rice var. Pusa Basmati-1 in Saran district of Bihar. *Asian J Pl Sci and Res* **5** (2): 82-85

Muamba J K and Shankar A G (2013). Effect of different levels of zinc on growth and uptake ability in rice zinc contrast lines (Oryza Sativa L.) *Asian J Pl Sci and Res* **3** (3):112-116

Quijano Guerta C, Kirk G J D, Portugal A M, Bartolome VI, McLaren GC (2002). Tolerance of rice germplasm to zinc deficiency. *Field Crop Res* **76:** 123–130

Rahman M T, Jahiruddind M, Humauan M R, Alamand M J, Khan A A (2008). Effect of Sulphur in Zinc on growth and yield and nutrient uptake of boro rice (cv. BRRI Dhan-29). *J Soil Nature* **2**(3):10-15.

Rahmatullah Khan, Ali Raza Gurmani, Mohammad Sohail khan and Akber Hussain Gurmani (2007) Effect of zinc application on rice yield under wheat rice system. *Pakistan J Biol Sci* **10**(2): 235-239

Shehu H E and Jamala G Y (2010) Available Zn distribution, response and uptake of rice (Oryza sativa) to applied Zn along a toposequence of lake Gerio Fadama soils at Yola, north-eastern Nigeria. *J Am Sci* **6**:1013–1016.

Received on 01/02/2021 *Accepted on 15/04/2021*